Final Report

on

PHASE I. INTEGRATED COMMUNITY ENERGY PLAN FOR RIVERSIDE, CALIFORNIA

Contract W-7405-ENG-92, Task 100

Volume 1

to

U.S. Department of Energy
Office of Assistant Secretary for Environment
Office of Technology Impacts
Division of Regional Assessments
Office of Assistant Secretary for Conservation
and Solar Applications
Division of Buildings and Community Systems

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January 31, 1979

Dr. Paul Cho
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Dear Dr. Cho:

Final Report on Phase 1
Integrated Community Energy Plan, Riverside, California
Contract W-7405-ENG-92, Task 100

Enclosed is the Final Report on Phase 1. Integrated Community Energy Plan, Riverside, California. Copies have also been sent to all members of the Advisory Committee including Mr. Paul Dickinson and Mr. I.O. Sewell.

The report is submitted in three parts. Volume 1 includes an Abstract, Executive Summary, and a more detailed description of project background, objective and scope, findings, and recommendations. Volumes 2 and 3 consist of the appendices in support of Volume 1. Included in the appendices are a section on methodology and sections on individual tasks.

The Battelle project staff has appreciated the opportunity to work with you, other DOE staff members, and the people of Riverside. We are particularly proud that we have been able to contribute to such a significant project. We feel this work has resulted in an excellent energy planning base for the City of Riverside, and should also be useful as a model for energy planning in other communities and/or regions. During the course of the program, considerable effort by many persons and organizations has resulted in the establishment of an enthusiastic group of persons dedicated to implementing an alternative energy plan in Riverside.

Sincerely,

Kenneth Cochran

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Many individuals, organizations and sources have contributed to this program and report, and to all of them we offer our gratitude and thanks.

Battelle wishes to thank the U.S. Department of Energy staff associated with the program who gave much support, understanding and guidance as Advisory Committee Members and during the course of the work. They were: Dr. Paul Cho, Project Officer; Mr. I. O. Sewell; and Mr. Paul Dickinson, San Francisco Operations.

It is impossible to list all those individuals and organizations in Riverside who helped so much as advisory committee members and/or privately to make the program a success. Battelle especially wishes to thank the following persons who were close to the program: Mr. Everett Ross, Dr. Robert Zweig, Dr. O. C. Taylor, Mr. Herb Rogers, Mr. Eric Haley, Ms. Rosanna Scott, Mr. David Sparks, Mr. Dean Boen, Mr. Ron Nordstrom and Mr. Peter Zweig. Also, Dr. Meir Carasso of the California Energy Commission, and Dr. Tom Moss and Mr. Tim Lynch of Congressman George Brown's staff, all of whom made substantial contributions to the program.

Battelle also thanks all the persons in the city, county and state offices, in the business community, in industry, and at the University of California, Riverside, for their help in providing data and guidance. The Riverside Chamber of Commerce and the Riverside Public Utilities Department are given special thanks for their assistance.

Many Battelle staff contributed to the program. Those most closely involved were: David A. Ball; Clarence Bloomster, BNW; Kenneth E. Cochran, program manager; Richard Craig; Richard Engdahl; Linda Fassbender, BNW; Karen Fitch; John R. Hagely; Frank Jakob; David Jenkins; Thomas R. Martineau; Louis Myers; Robert H. Poirier; George Stickford; Dr. Philip Sticksel; Roger W. Sullivan; Sherwood Talbert; Lawrence Welling; Linda Wilcox; Dr. Allen White.

ABSTRACT

In July 1977, the U.S. Department of Energy awarded a Phase I contract to Battelle-Columbus Laboratories to assist the City of Riverside, California in developing an integrated community energy plan. The total research appropriation was $326,000. The primary objective was to develop an integrated community energy plan for Riverside. The basic subobjectives of Phase I were to:

- Perform a general energy audit of the City, develop demand profiles, and prepare projections of total energy demand to the year 2000.
- Select one or more energy strategies combining conservation and alternative energy supply options which will fulfill requirements of decreasing the use of natural gas and/or oil, increase energy stability, and reduce locally generated air pollution.
- Present the final results in a written report.
- Evolve a methodology and policy for working with local, County, regional, State and Federal institutions on integrated energy/environmental problems.

During the course of the study numerous activities were completed. Baseline information was collected regarding energy consumption patterns, current environmental conditions, conservation activities, indigenous alternative energy resources, legal/institutional factors and existing educational programs. Candidate conservation and alternative energy supply options were identified and screened. The surviving candidate options covered the following broad areas: conservation: buildings, community design, industrial processes, and transportation; alternative energy: coal, solar, geothermal, and waste-to-energy.

Alternative energy strategies, including conservation and alternative energy options, were recommended and evaluated in terms of energy savings and environmental impact as well as a series of secondary outcomes and feasibility factors. The latter included the local economy, energy supply stability, lifestyle, public acceptance, legal/institutional constraints, technology availability, and public/private sector costs.

It was determined that under a high impact assumption in the year 2000 purchased energy for Riverside based on natural gas and oil could be about one-half of that in 1976 and about one-third of that in 2000 on a business-as-usual basis. Business-as-usual was defined as no significant changes in per capita consumption of energy or lifestyle between 1976 and 2000. Projected demand would be reduced by means of conservation and alternative energy resources including (1) a coal and refuse-fired integrated utility system in Riverside which would also supply steam for industrial and commercial use and electricity, (2) solar energy for residential use, and (3) some methane recovery from waste for general heating use. Hydrogen, produced by electrolysis, would be used in Riverside's municipal fleet.

Several benefits are expected to accrue to the City of Riverside in the year 2000 if the recommended maximum strategy and action plan are implemented. These are:

- A high degree of reliability of energy supply based on conservation and alternative energy supply sources
- A reduced dependence on electric utility power because of an in-community generation capability
- Reduced total energy costs to the consumer based on the projected cost of energy to the year 2000
- A minimum risk, because of the use of proven technology.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Con't)

TABLE OF CONTENTS
(Con't)

TABLE OF CONTENTS
(Con't)

TABLE OF CONTENTS
(Con't)

LIST OF TABLES

TABLE OF CONTENTS
(Con't)

TABLE OF CONTENTS
(Con't)

LIST OF TABLES

TABLE OF CONTENTS
(Con't)

LIST OF TABLES

TABLE OF CONTENTS
(Con't)

LIST OF FIGURES

LIST OF FIGURE (Continued)

LIST OF APPENDICES

EXECUTIVE SUMMARY

INTRODUCTION

The United States in the past 5 to 10 years has acquired a new awareness of its sources of energy and how these sources can be used to supply the many needs of the American people. Two major factors prompting this awareness were: (1) difficulty in meeting demands for natural gas, and (2) the Arab oil embargo of 1973.

In 1977 the United States was about 75 percent dependent on natural gas and oil for its total energy needs. Today, about half of our oil is imported from foreign countries, whereas in 1973, the year of the embargo, only about one-third was imported.

Because of the decline in natural gas supplies, coupled with our high reliance on imported oil, officials at nearly all levels of government are faced with the formidable task of developing plans and policies which will stimulate conservation, the increased discovery of new domestic natural gas and oil reserves, as well as a shift to the use of renewable energy sources to meet a portion of our future energy needs. To facilitate the planning process it is important to know and understand the energy needs at the community level and to know what options are available for meeting these needs.

This study addresses the particular energy needs for the community of Riverside, California. Riverside is in the heart of Southern California and is typical of many communities in the Southwest. The Southern California area is one of the major population centers of the United States, is nearly 90 percent reliant on natural gas and oil for its energy needs, and has an especially sensitive balance between environment and the ways in which energy needs are met.

These needs, coupled with the strong local support in Riverside and the interest of the California Energy Resources Conservation and Development Commission, were matched with the plans of the U.S. Department of Energy (DOE) to support a program for studying the development of an integrated community energy plan for the City of Riverside.

As a result, in July, 1977, the U.S. Department of Energy established the Integrated Community Energy Planning Program for Riverside, California. A $326,000 contract was awarded to Battelle's Columbus Division to assist the City in developing the plan.

OBJECTIVES AND SCOPE

The primary objective was to develop an integrated community energy plan for the City of Riverside. Basic subobjectives for the Phase I Program were to:

- Perform a general energy audit of the City of Riverside, develop demand profiles, and make projections of energy demand to the year 2000.
- Select an alternative energy strategy combining conservation options and available alternative energy sources that will fulfill requirements of decreasing the use of scarce fossil fuels, increase energy stability, and reduce locally generated environmental pollution.
- Present the final results in a written report.

Within the scope of this program, considerable site-specific baseline data were collected or developed on present energy use, energy conservation activities, indigenous alternative energy resources, environmental conditions and intergovernmental relationships and policies. These data were used to project energy demand profiles to the year 2000. Energy conservation and alternative energy supply opportunities were identified and screened. Surviving options were then evaluated in terms of primary and secondary outcomes as well as a set of feasibility factors. Alternative energy strategies were identified and action plans were prepared. All of the baseline data generated during this study should provide a proper data base for decision making and, combined with the recommended energy strategies, should be of immediate use to both the City of Riverside and County and State planners.

Methodology development that would be useful as a model for other communities was also a major concern of the program.

Significant community involvement was achieved during the Phase I Program; however, more extensive community involvement will be required during subsequent phases of the program before final energy strategies can be selected and implemented in Riverside. An important activity in Phase I was infrared aerial photography of the entire city. The photos produced will be used by the City's Public Utilities Department, the Riverside Chamber of Commerce, and the Southern California Gas Company as a basis for a public energy awareness program.

RECOMMENDATIONS

To achieve maximum reduction in dependence on natural gas and oil in the year 2000, Battelle recommends that the City of Riverside proceed immediately to implement one of the alternative energy strategies as listed in Table ES-1.

Accompanying each recommended strategy is an Action Plan. Each Plan contains a list of actions required to implement the conservation and alternative supply options included in that specific strategy. Also included are certain administrative actions required to organize and prepare for technical implementation, as well as various research actions required for feasibility analysis, demonstration, monitoring, and evaluation. Most actions can be implemented and completed without further research. The Action Plan is presented in the format of a time schedule and certain actions take only a short time to implement and complete, such as the establishment of a City Energy Coordinator. Others, such as the integrated utility system may require several years to implement because of the need for further feasibility analysis, demonstration, planning, and construction.

Impact of Recommended Alternatives Energy Strategies in Riverside

The recommended alternative energy strategies were evaluated in terms of primary and secondary outcomes, as well as feasibility of implementation.

TABLE ES-1. RECOMMENDED CONSERVATION, ALTERNATIVE ENERGY SUPPLY, AND INSTITUTIONAL OPTIONS

	Options	Alternative Strategy A (Minimum)	Alternative Strategy B (Moderate)	Alternative Strategy C (Maximum)
1.	Appoint a City Energy Coordinator	X	X	X
2.	Administer New Residential and Nonresidential State Energy Codes	X	X	X
3.	Develop and Implement an Ongoing Educational Program to Improve the Efficiency of Industrial Processes and Operations in Small Industry	X	X	X
4.	Develop and Implement a Land-Use Policy Emphasizing Concentrated Planned Neighborhood Development Incorporating Mixed Land Uses	X	X	X
5.	Develop and Implement an Ongoing Educational Program to Encourage the Use of Solar Water and Space Heating	X	X	X
6.	Invest in Remote Conventional Generating Plants	X	X	X
7.	Reevaluate Remote Nonconventional Generating Plants Based on Future Technology	X	X	X
8.	Reevaluate an Integrated Utility System Based on Future Technology	X	X	X
9.	Develop and Implement a Planning Policy to Encourage the Use of Passive Solar Building Design		X	X
10.	Develop and Implement a Solar-Based Zoning Ordinance		X	X
11.	Develop and Implement a Winter Performance Standard for New Residential Units (single-family and duplex only) Incorporating Passive Solar Thermal (heat gain) Considerations		X	X
12.	Develop and Implement a Minimum Summer Performance Standard for New and Existing Residential Units (single-family and low-rise) Incorporating Passive Solar Shading and Shielding Requirements		X	X
13.	Replace Existing Incandescent Street Lights with High Pressure Sodium Lights		X	X
14.	Reduce Total Energy Demand in the Street Lighting System		X	X
15.	Develop and Implement an Ongoing Education Program on Van Pooling, Car Pooling, Purchasing Fuel-Efficient Vehicles, and Driving Efficiencies		X	X
16.	Implement Hydrogen Production for the Municipal Fleet		X	X
17.	Obtain and Distribute Methane from Waste Landfill		X	X
18.	Develop and Implement a Building Retrofit Energy Code			X
19.	Develop and Implement a Land-Use Policy to Modify the Existing Housing Mix			X
20.	Continue Upgrading Energy Code(s)			X
21.	Evaluate a Geothermal District Heating System			X

Primary outcomes cover the effect of conservation and alternative energy supply options on both energy demand and environmental quality. Primary outcome relative to energy demand is the amount of reduction in consumption through displacement of natural gas and oil. Primary outcome relative to environmental quality is the amount of reduction or increase in emissions for hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulates. The effect of each conservation and alternative energy supply option on environmental quality, along with energy savings, secondary outcomes, and feasibility evaluation for low, moderate and high population growth is shown in Tables ES-2, ES-3, and ES-4. Secondary outcomes and feasibility evaluation consisted of a qualitative analysis of selected factors including the local economy, energy supply stability, life-style, public acceptance, legal/institutional constraints, technological availability, and public/private sector costs. These tables also show the numerical values assigned during the qualitative evaluation and categorical ranking of each conservation and supply option. Options having the same relative ranking were clustered and became the basis for selecting specific alternative energy strategies.

The potential impact on energy supply of selected conservation and supply options evaluated in this study is illustrated graphically in Figure ES-1. This figure is divided into four bars - business as usual, minimum strategy/low impact, moderate strategy/moderate impact, maximum strategy/high impact. The following describes the basic assumptions and contents in each bar.

Business as Usual - This bar represents the mix of energy sources that would be used in the year 2000 if current trends continue. Specific assumptions were (1) electric demand growth at 4 percent per year,* (2) population growth 2.17 percent per year,** (3) natural gas demand growth 2.17 percent per year (constant per capita consumption) and (4) vehicle oil demand 2.17 percent per year.

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* Growth rate projected by the Riverside Public Utilities Department.

** This represents the high population growth rate considered elsewhere in this study. This growth rate appears most likely for Riverside based on discussions with the Riverside Public Utilities Department.

TABLE ES-2. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF LOW POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings: Impact	Energy Savings: Savings (BTU's x 10^{12})	Environmental Impact (Decrease in Emissions, lb x 10^3/yr): HC	CO	NO_x	SO_2	Particulates	Secondary Outcomes: Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Feasibility: Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value	Total All Values	Category
Conservation																							
(C1) Building Retrofit Code	Low Moderate High	.660 (a) .923 (a) 1.186 (a)	4.3 6.1 7.8	8.3 11.5 14.9	152.3 212.6 272.0	86.6 120.9 154.4	10.3 14.4 18.4	Significant increase in cost of administering codes; significant increase in building trades employment and sales of building materials, i.e, insulation, storm windows	7	No appreciable effect	5	Increased comfort due to reduced infiltration, heat gains, heat loss	8	Probable rejection of added costs particularly among low and moderate income homeowners as well as business	3	Need to adopt retrofit code; increase in plan review and inspection staff; probable political opposition	1	Technology required readily available	10	Life cycle costs about the same or slightly lower	6	40	C
(C2) State Energy Code	Low Moderate High	.187 (a) .333 (a) .508 (a)	1.2 2.1 3.8	2.6 4.8 7.5	41.4 70.5 132.7	23.0 38.6 74.9	2.8 4.8 9.0	Some increase in cost of administering building code; some increase in sales of building materials, i.e., insulation, insulating glass	6	No appreciable effect	5	Increased comfort in new building due to reduced infiltration, heat gain, and heat loss	10	Definitely acceptable, costs already included in construction costs	10	Need to educate staff; additional plan review	9	Same as above	10	Life cycle costs significantly lower than business as usual	8	58	A
(C3) Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable		–	–	–	–	–	No appreciable effect	5	No effect	5	Increased comfort due to reduced infiltration, heat gain, and heat loss	10	Public acceptance depends upon degree of change and cost; probable limited opposition, generally	8	No major obstacles	8	No constraints anticipated at this time	10	Life cycle costs about the same as business as usual	5	51	B
(C4) Modified Housing Mix	Low Moderate High	.013 (b) .044 (b) .08 (b)	.11 .47 .84	.26 .89 1.6	4.8 16.1 29.5	2.7 9.2 16.7	.33 1.1 2.0	No effect on employment or general revenue fund	5	No appreciable effect	5	Some reduction in privacy	7	Possible opposition to spatial distribution and staging of new multifamily units; changes in overall density	4	Probable opposition to rezoning; rezoning hearings required	4	Same as above	10	Life cycle costs somewhat lower than business as usual	6	41	C
(C5) Energy-Efficient Neighborhood Development	High Only	.321 (b)	192.6	2535.9	417.3	16.1	41.7	Seen as more secure investment due to initial value and capability of projecting future value. Less subject to abrupt changes effecting property values	10	Reduction in demand for vehicle fuel in Riverside; no effect on reliability	5	Reduced dependence on auto; more leisurely environment; greater perception of personal safety; greater emphasis on preserving nature	10	Marketing of energy efficiency and new lifestyle could create a backlog of occupants; early possible opposition to development standards by builders	8	Some modifications and integration of C-1 and planned residential development (PRD) uses required; probable political opposition	6	Same as above	10	Life cycle costs significantly lower than business as usual	8	57	A
(C6) Planning Policy to Encourage Use of Passive Solar Building Design (Building Orientation)	No Direct Savings Attributable		–	–	–	–	–	No effect on employment. Increased building value over buildings with traditional orientation adding to municipal tax revenues	6	Some increase in supply stability due to use of alternative energy resource and some displacement	6	Reduction in variety of street layout	8	Possibly some opposition by builders/developers	9	Some difficulty in developing and adopting a solar-based zoning ordinance and revising subdivision code	4	No constraint	10	Life cycle costs somewhat lower than business as usual	6	49	B
(C7) Passive Solar Thermal Standard	Low Moderate High	.141 (b) .231 (b) .266 (b)	.494 .809 .931	4.230 6.930 7.980	13.677 22.407 25.802	.085 .139 .160	.846 1.386 1.596	Same as above	6	Slight increase in supply stability due to expected use of alternative energy resource and some displacement	6	Possible reduction in variety of building design; possible loss of living space	8	Increased property value should offset any opposition to design similarity or loss of space; probable builder opposition to standards	10	Same as above	4	Currently some limitations exist in efficient thermal storage, expected to be resolved before 2000	8	Life cycle costs about the same as business as usual	5	47	B
(C8) Passive Solar Cooling Standard	Low Moderate High	.126 (b) .187 (b) .286 (b)	2.268 3.366 5.148	.044 .065 .100	80.64 119.68 183.04	52.668 78.166 119.548	5.544 8.228 12.584	Same as above	6	No effect because electricity is generated outside the city and the city has no control over	5	Improved temperature control for the building and adjacent areas such as patios	10	Same as above	10	Same as above	4	Same as above	9	Life cycle costs somewhat lower than business as usual	6	50	B
(C9) Convert Incandescent Lights to High Pressure Sodium	Low Moderate High	.014 (b) .014 (b) .014 (b)	.50 .50 .50	.01 .01 .01	17.9 17.9 17.9	11.7 11.7 11.7	1.2 1.2 1.2	Some capital investment by city; some reduction in operating cost to City. No effect on employment	5	Same as above	5	Loss of warmth and intimacy due to change in lighting effect	5	No obstacles	10	No obstacles	10	Technology required readily available	10	Life cycle costs about the same or slightly higher than business as usual	4	49	B
(C10) Reduce Total Energy Demand in Street Lighting	Low Moderate High	.033 (b) .038 (b) .105 (b)	.594 .684 1.89	.012 .013 .037	21.12 24.32 67.2	13.794 15.884 43.89	1.452 1.672 4.62	Capital investment required by City. No effect on employment	5	Same as above	5	Possible decrease in perception of safety	7	Possible negative response to reduced lighting levels	6	No obstacles	9	Same as above	10	Life cycle costs somewhat lower than business as usual	6	48	B
(C11) Education Program to Improve Efficiency of Industrial Processes and Operations	Low Moderate High	.533 (c) .791 (c) 1.045 (c)	.533 .791 1.045	2.132 3.164 4.18	94.341 506.240 184.965	99.671 147.917 195.415	4.797 7.119 9.405	No appreciable effect	5	No appreciable effect	5	No effect	10	No obstacles	10	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	7	57	A
(C12) Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low Moderate High	.696 (d) 1.043 (d) 1.393 (d)	417.6 625.8 835.8	5498.4 8239.7 11004.7	904.8 1355.9 1810.9	34.8 52.2 69.7	90.5 135.6 181.1	Some decrease in tax income from fuels; savings realized by individuals	6	No effect	5	Less privacy in travel; fewer options in choice of vehicle size; contention with possible restrictions discouraging private autos	6	Low probability of acceptance due to resistance to change in use of private autos	2	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	8	47	B

Table ES-2. (Continued)

Options	Energy Savings: Impact	Energy Savings: Savings (BTU's x 10^{12})	Environmental Impact (Decrease in Emissions, lb x 10^3/yr): HC	CO	NO_x	SO_2	Particulates
Supply							
(S1) Solar Water and Space Heating	Low Moderate High	0.8 (f) 1.0 (f) 1.9 (f)	2.8 3.5 6.6	28. 35. 66.	78. 98. 186.	0.5 0.6 1.1	4.8 6.0 11.4
(S2) Investment in Remote Conventional Generating Plants, Coal/Nuclear	All	14.3 (i)	257.	5.	9152.	6000.	630.
(S3) Investment in Remote Nonconventional Generating Plants, Geothermal/Wind	All	14.3 (i)	257.	5.	9152.	6000.	630.
(S4) Integrated Utility System Based on Gasification of Coal and Refuse	Low Moderate High	5.9 (e) 7.2 (e) 8.7 (e)	100. 120. 150.	-65. -80. -100.	1600. 2000. 2500.	600. 800. 1000.	65. 80. 100.
(S5) Hydrogen Production for Captive Vehicle Fleet	All	0.21 (j)	126.	1659.	273.	10.5	27.3
(S6) Methane From Wastes. Landfill, Feedlot Manure, Sewage Sludge	All	0.2 (h)	Essentially No Change				
(S7) Geothermal District Heating/Cooling	Low Moderate High	1.9 (g) 2.3 (g) 2.8 (g)	51. 62. 76.	39. 48. 58.	184. 224. 273.	1.1 1.4 1.7	11. 14. 17.

Options	Secondary Outcomes: Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Feasibility: Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value	Total All Values	Category
(S1) Solar Water and Space Heating	Systems require variable investment depending on degree of service desired	6	Shifts reliance to nondepletable resource. Requires backup under normal conditions. Would be functional under upset conditions	7	Negligible	5	Excellent – may even override some degree of increased cost over next best alternative	10	No effect. Systems are currently being commercially installed	10	Commercial – Advancements offer hope of lower costs	10	Can be cost competitive with electric heat but probably not with natural gas. Will increase local trades employment	8	56	A
(S2) Investment in Remote Conventional Generating Plants, Coal/Nuclear	Investment is variable depending on degree of service desired. Benefit is linear with investment	9	Shifts reliance to nonscarce resource. Highly dependable under normal conditions. Not dependable under upset conditions	7	Negligible	5	Public acceptance has had major impact on failure of previous projects such as Kaiparowits and Sundesert	6	Legal and institutional mechanisms already exist	10	Commercial – However, pollution control and waste disposal require development	8	Would result in lower cost of electric power for Riverside residents	10	55	A
(S3) Investment in Remote Nonconventional Generating Plants, Geothermal/Wind	Same as above. Cost/benefit uncertain at this time	6	Shifts reliance to nonscarce or nondepletable resource. Dependability under normal and upset conditions needs to be proven	8	Negligible	5	Probably somewhat less negative than to S2 due to newness of technology	6	Could be handled under same agreement as S2. Some additional problems exist for geothermal	9	Noncommercial Both geothermal and wind will require development and economic demonstration	7	Would result in lower cost of power contingent on technology development	7	48	B
(S4) Integrated Utility System Based on Gasification of Coal and Refuse	Large investment required even for minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Less dependable than S2 under normal conditions – somewhat more dependable under upset conditions	7	Some temporary disruptive effect due to construction	4	Will depend largely on how effectively project can be sold to the public. Unlike S2 and S3 the people most affected by the plant are those who benefit from its service	5	Could be handled under same conditions as S2. Plant generator would need mechanism for sale of steam and chilled water	9	Noncommercial. Projected technology commercialization in late 1980's	7	Would result in lower cost of power contingent on technology development. Would increase local employment. Requires substantial initial investment	7	45	B
(S5) Hydrogen Production for Captive Vehicle Fleet	Moderate to large investment required. Benefit increases with investment	5	Shifts reliance to nonscarce resource. Increased dependability of fuel supply. Engine dependability needs demonstration	7	Negligible	5	Good for general public for environmental reasons. Poor for drivers and mechanics which could seriously affect success of project	5	No effect	10	Noncommercial. Both production and end use systems require development and demonstration	7	Negligible impact	5	44	B
(S6) Methane From Wastes. Landfill, Feedlot Manure, Sewage Sludge	Relatively small investment required	6	Shifts reliance to nondepletable resource. Dependability under normal and upset conditions lower than conventional natural gas	6	Negligible	5	Little or no public reaction expected	5	No effect. Systems are currently in commercial use in other locations	10	Commercial	8	Potentially lower cost of natural gas but probably negligible impact	5	45	B
(S7) Geothermal District Heating/Cooling	Large investment for even minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Dependability under normal conditions needs demonstration. Dependability under upset conditions somewhat higher than S2, S3, and S4	7	Some temporary disruptive effect due to construction	3	Somewhat more acceptable than S3	5	Plant operator would need mechanism for sale of hot water	9	Noncommercial. Possibilities depend highly on resource characteristics	3	May result in lower heating and cooling costs. Highly dependent on resource capacity and characteristics	7	40	C

For assumptions and detailed calculations, see
- (a) Volume 2, Appendix C1, Attachment C1-1.
- (b) Volume 2, Appendix C4, Attachment C4-1.
- (c) Volume 2, Appendix C2, Attachment C2-2.
- (d) Volume 2, Appendix C3, Attachment C3-1.
- (e) See Appendices D9–D10.
- (f) See Appendix D2.
- (g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9–D10.
- (h) See Appendix D5.
- (i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
- (j) See Appendix C3, Attachment C3-1.

TABLE ES-3. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF MODERATE POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings: Impact	Energy Savings: Savings (BTU's x 10^{12})	Environmental Impact (Decrease in Emissions, lb x 10^3/yr): HC	CO	NO_x	SO_2	Particulates
Conservation							
(C1) Building Retrofit Code	Low Moderate High	.660 (a) .923 (a) 1.186 (a)	4.3 6.1 7.8	8.3 11.5 14.9	152.3 212.6 272.0	86.6 120.9 154.4	10.3 14.4 18.4
(C2) State Energy Code	Low Moderate High	.283 (a) .476 (a) .715 (a)	1.8 2.9 4.4	4.1 7.1 10.5	63.7 101.5 153.3	35.2 55.3 83.8	4.3 6.9 10.4
(C3) Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable		–	–	–	–	–
(C4) Modified Housing Mix	Low Moderate High	.025 (b) .079 (b) .142 (b)	.26 .83 1.5	.5 1.6 2.8	9.2 29.1 52.3	5.2 16.5 29.7	.63 2.0 3.6
(C5) Energy-Efficient Neighborhood Development	High Only	.573 (b)	343.8	4526.7	744.9	28.7	74.5
(C6) Planning Policy to Encourage Use of Passive Solar Building Design (Building Orientation)	No Direct Savings Attributable		–	–	–	–	–
(C7) Passive Solar Thermal Standard	Low Moderate High	.252 (b) .412 (b) .475 (b)	.882 1.442 1.663	7.560 12.360 14.260	24.444 39.964 46.075	.151 .247 .285	1.512 2.472 2.850
(C8) Passive Solar Cooling Standard	Low Moderate High	.187 (b) .293 (b) .393 (b)	3.4 5.3 7.1	.065 .103 .138	119.7 187.5 251.5	78.2 122.5 164.3	8.2 12.9 17.3
(C9) Convert Incandescent Lights to High Pressure Sodium	Low Moderate High	.014 (b) .014 (b) .014 (b)	.50 .50 .50	.01 .01 .01	17.9 17.9 17.9	11.7 11.7 11.7	1.2 1.2 1.2
(C10) Reduce Total Energy Demand in Street Lighting	Low Moderate High	.038 (b) .076 (b) .114 (b)	.68 1.37 2.05	.013 .03 .04	24.3 48.6 72.9	15.9 31.8 47.7	1.7 3.3 5.0
(C11) Education Program to Improve Efficiency of Industrial Processes and Operations	Low Moderate High	.627 (c) .927 (c) 1.223 (c)	.63 .93 1.22	2.5 3.7 4.9	110.9 164.1 216.5	117.3 173.4 228.7	5.6 8.3 11.0
(C12) Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low Moderate High	.801 (d) 1.202 (d) 1.603 (d)	480.6 721.2 961.8	6327.9 9495.8 12683.7	1041.3 1562.6 2083.9	40.1 60.1 80.2	104.1 156.3 208.4

Options	Secondary Outcomes: Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Feasibility: Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value	Total All Values	Category
Conservation																
(C1) Building Retrofit Code	Significant increase in cost of administering codes; significant increase in building trades employment and sales of building materials, i.e., insulation, storm windows	7	No appreciable effect	5	Increased comfort due to reduced infiltration, heat gains, heat loss	8	Probable rejection of added costs particularly among low and moderate income homeowners as well as business	3	Need to adopt retrofit code; increase in plan review and inspection staff; probable political opposition	1	Technology required readily available	10	Life cycle costs about the same or slightly lower	6	40	C
(C2) State Energy Code	Some increase in cost of administering building code; some increase in sales of building materials, i.e., insulation, insulating glass	6	No appreciable effect	5	Increased comfort in new building due to reduced infiltration, heat gain, and heat loss	10	Definitely acceptable, costs already included in construction costs	10	Need to educate staff; additional plan review	9	Same as above	10	Life cycle costs significantly lower than business as usual	8	58	A
(C3) Continued Upgrading of Energy Codes for New and Existing Buildings	No appreciable effect	5	No effect	5	Increased comfort due to reduced infiltration, heat gain, and heat loss	10	Public acceptance depends upon degree of change and cost; probable limited opposition, generally	8	No major obstacles	8	No constraints anticipated at this time	10	Life cycle costs about the same as business as usual	5	51	B
(C4) Modified Housing Mix	No effect on employment or general revenue fund	5	No appreciable effect	5	Some reduction in privacy	7	Possible opposition to spatial distribution and staging of new multifamily units; changes in overall density	4	Probable opposition to rezoning; rezoning hearings required	4	Same as above	10	Life cycle costs somewhat lower than business as usual	6	41	C
(C5) Energy-Efficient Neighborhood Development	Seen as more secure investment due to initial value and capability of projecting future value. Less subject to abrupt changes effecting property values	10	Reduction in demand for vehicle fuel in Riverside; no effect on reliability	5	Reduced dependence on auto; more leisurely environment; greater perception of personal safety; greater emphasis on preserving nature	10	Marketing of energy efficiency and new lifestyle could create a backlog of occupants; early possible opposition to development standards by builders	8	Some modifications and integration of C-1 and planned residential development (PRD) uses required; probable political opposition	6	Same as above	10	Life cycle costs significantly lower than business as usual	8	57	A
(C6) Planning Policy to Encourage Use of Passive Solar Building Design (Building Orientation)	No effect on employment. Increased building value over buildings with traditional orientation adding to municipal tax revenues	6	Some increase in supply stability due to use of alternative energy resource and some displacement	6	Reduction in variety of street layout	8	Possibly some opposition by builders/developers	9	Some difficulty in developing and adopting a solar-based zoning ordinance and revising subdivision code	4	No constraint	10	Life cycle costs somewhat lower than business as usual	6	49	B
(C7) Passive Solar Thermal Standard	Same as above	6	Slight increase in supply stability due to expected use of alternative energy resource and some displacement	6	Possible reduction in variety of building design; possible loss of living space	8	Increased property value should offset any opposition to design similarity or loss of space; probable builder opposition to standards	10	Same as above	4	Currently some limitations exist in efficient thermal storage; expected to be resolved before 2000	8	Life cycle costs about the same as business as usual	5	47	B
(C8) Passive Solar Cooling Standard	Same as above	6	No effect because electricity is generated outside the city and the city has no control over	5	Improved temperature control for the building and adjacent areas such as patios	10	Same as above	10	Same as above	4	Same as above	9	Life cycle costs somewhat lower than business as usual	6	50	B
(C9) Convert Incandescent Lights to High Pressure Sodium	Some capital investment by city; some reduction in operating cost to City. No effect on employment	5	Same as above	5	Loss of warmth and intimacy due to change in lighting effect	5	No obstacles	10	No obstacles	10	Technology required readily available	10	Life cycle costs about the same or slightly higher than business as usual	4	49	B
(C10) Reduce Total Energy Demand in Street Lighting	Capital investment required by City. No effect on employment	5	Same as above	5 .	Possible decrease in perception of safety	7	Possible negative response to reduced lighting levels	6	No obstacles	9	Same as above	10	Life cycle costs somewhat lower than business as usual	6	48	B
(C11) Education Program to Improve Efficiency of Industrial Processes and Operations	No appreciable effect	5	No appreciable effect	5	No effect	10	No obstacles	10	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	7	57	A
(C12) Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Some decrease in tax income from fuels; savings realized by individuals	6	No effect	5	Less privacy in travel; fewer options in choice of vehicle size; contention with possible restrictions discouraging private autos	6	Low probability of acceptance due to resistance to change in use of private autos	2	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	8	47	B

TABLE ES-3. (Continued)

Options	Energy Savings: Impact	Energy Savings: Savings	Environmental Impact (Decrease in Emissions, lb x 10^3/yr): HC	CO	NO_x	SO_2	Particulates	Secondary Outcomes: Local Economy: Impact/Effect	Value	Energy Supply Stability: Impact/Effect	Value	Lifestyle: Impact/Effect	Value	Feasibility: Public Acceptance: Impact/Effect	Value	Legal/Institutional: Impact/Effect	Value	Technology Availability: Impact/Effect	Value	Public/Private Sector Costs: Impact/Effect	Value	Total All Values	Category
Supply		(BTU's x 10^{12})																					
(S1) Solar Water and Space Heating	Low Moderate High	1.0 (f) 1.2 (f) 2.0 (f)	3.5 4.2 6.7	35. 42. 67.	98. 118. 188.	0.6 0.7 1.1	6.0 7.2 11.5	Systems require variable investment depending on degree of service desired	6	Shifts reliance to nondepletable resource. Requires backup under normal conditions. Would be functional under upset conditions	7	Negligible	5	Excellent – may even override some degree of increased cost over next best alternative	10	No effect. Systems are currently being commercially installed	10	Commercial – Advancements offer hope of lower costs	10	Can be cost competitive with electric heat but probably not with natural gas. Will increase local trades employment	8	56	A
(S2) Investment in Remote Conventional Generating Plants, Coal/Nuclear	All	14.3 (i)	257.	5.	9152.	6000.	630.	Investment is variable depending on degree of service desired. Benefit is linear with investment	9	Shifts reliance to nonscarce resource. Highly dependable under normal conditions. Not dependable under upset conditions	7	Negligible	5	Public acceptance has had major impact on failure of previous projects such as Kaiparowits and Sundesert	6	Legal and institutional mechanisms already exist	10	Commercial – However, pollution control and waste disposal require development	8	Would result in lower cost of electric power for Riverside residents	10	55	A
(S3) Investment in Remote Nonconventional Generating Plants, Geothermal/Wind	All	14.3 (i)	257.	5.	9152.	6000.	630.	Same as above. Cost/benefit uncertain at this time	6	Shifts reliance to nonscarce or nondepletable resource. Dependability under normal and upset conditions needs to be proven	8	Negligible	5	Probably somewhat less negative than to S2 due to newness of technology	6	Could be handled under same agreement as S2. Some additional problems exist for geothermal	9	Noncommercial Both geothermal and wind will require development and economic demonstration	7	Would result in lower cost of power contingent on technology development	7	48	B
(S4) Integrated Utility System Based on Gasification of Coal and Refuse	Low Moderate High	7.2 (e) 8.7 (e) 10.5 (e)	120. 150. 180.	-80. -100. -120.	2000. 2500. 3000.	800. 1000. 1200.	80. 100. 120.	Large investment required even for minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Less dependable than S2 under normal conditions – somewhat more dependable under upset conditions	7	Some temporary disruptive effect due to construction	4	Will depend largely on how effectively project can be sold to the public. Unlike S2 and S3 the people most affected by the plant are those who benefit from its service	5	Could be handled under same conditions as S2. Plant generator would need mechanism for sale of steam and chilled water	9	Noncommercial. Projected technology commercialization in late 1980's	7	Would result in lower cost of power contingent on technology development. Would increase local employment. Requires substantial initial investment	7	45	B
(S5) Hydrogen Production for Captive Vehicle Fleet	All	0.24 (j)	144.	1896.	312.	12.	31.2	Moderate to large investment required. Benefit increases with investment	5	Shifts reliance to nonscarce resource. Increased dependability of fuel supply. Engine dependability needs demonstration	7	Negligible	5	Good for general public for environmental reasons. Poor for drivers and mechanics which could seriously affect success of project	5	No effect	10	Noncommercial. Both production and end use systems require development and demonstration	7	Negligible impact	5	44	B
(S6) Methane From Wastes. Landfill, Feedlot Manure, Sewage Sludge	All	0.2 (h)	Essentially No Change					Relatively small investment required	6	Shifts reliance to nondepletable resource. Dependability under normal and upset conditions lower than conventional natural gas	6	Negligible	5	Little or no public reaction expected	5	No effect. Systems are currently in commercial use in other locations	10	Commercial	8	Potentially lower cost of natural gas but probably negligible impact	5	45	B
(S7) Geothermal District Heating/Cooling	Low Moderate High	2.3 (g) 2.8 (g) 3.4 (g)	62. 76. 93.	48. 58. 71.	224. 273. 333.	1.4 1.7 2.1	14. 17. 21.	Large investment for even minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Dependability under normal conditions needs demonstration. Dependability under upset conditions somewhat higher than S2, S3, and S4	7	Some temporary disruptive effect due to construction	3	Somewhat more acceptable than S3	5	Plant operator would need mechanism for sale of hot water	9	Noncommercial. Possibilities depend highly on resource characteristics	3	May result in lower heating and cooling costs. Highly dependent on resource capacity and characteristics	7	40	C

For assumptions and detailed calculations, see
- (a) Volume 2, Appendix C1, Attachment C1-1.
- (b) Volume 2, Appendix C4, Attachment C4-1.
- (c) Volume 2, Appendix C2, Attachment C2-2.
- (d) Volume 2, Appendix C3, Attachment C3-1.
- (e) See Appendices D9-D10.
- (f) See Appendix D2.
- (g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
- (h) See Appendix D5.
- (i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
- (j) See Appendix C3, Attachment C3-1.

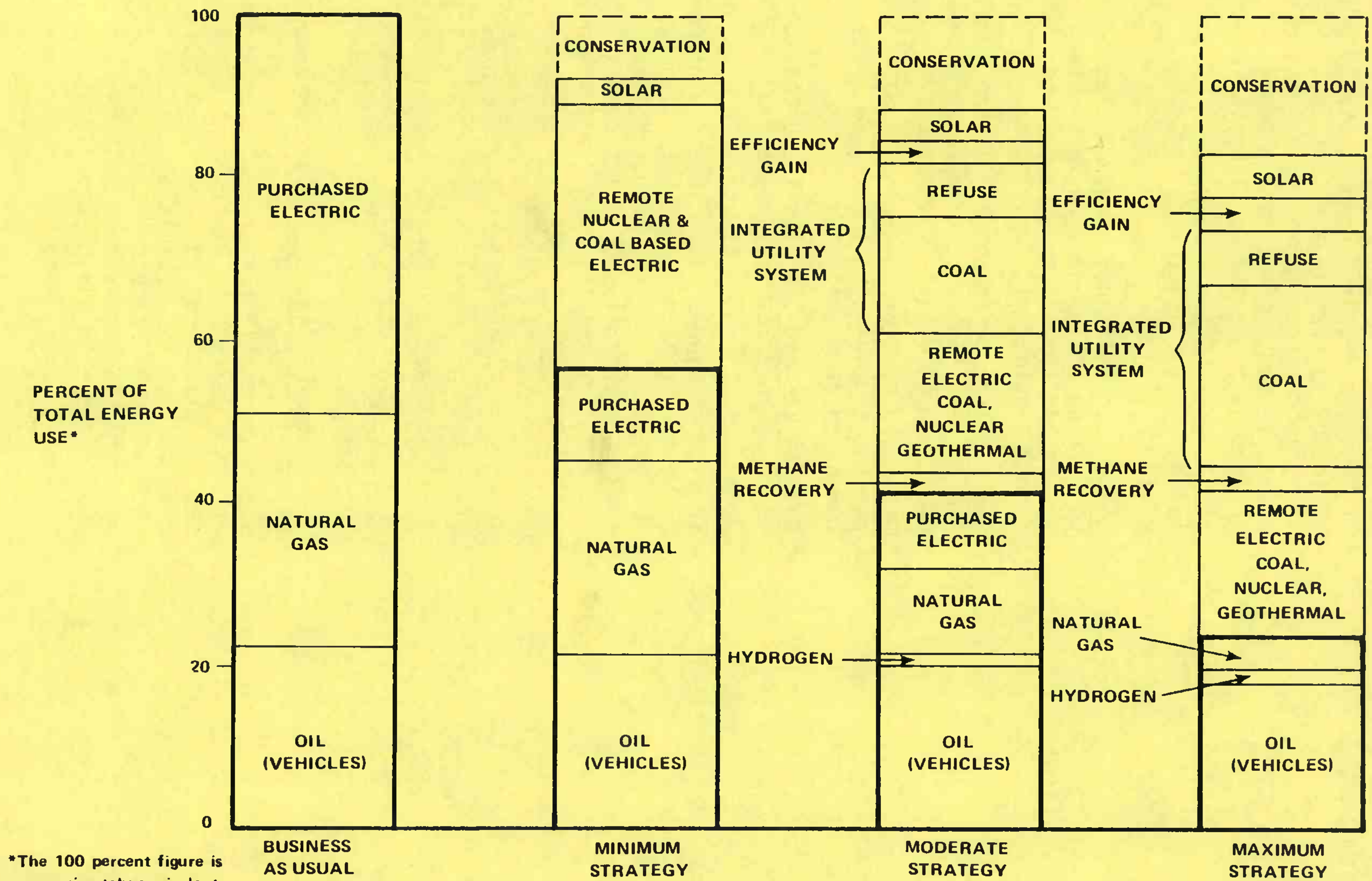
TABLE ES-4. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF HIGH POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings		Environmental Impact (Decrease in Emissions, lb x 10^3/yr)					Secondary Outcomes						Feasibility								Total All Values	Category
	Impact	Savings	HC	CO	NO_x	SO_2	Particulates	Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value		
Conservation		(BTU's x 10^{12})																					
(C1) Building Retrofit Code	Low Moderate High	.660 (a) .923 (a) 1.186 (a)	4.3 6.1 7.8	8.3 11.5 14.9	152.3 212.6 272.0	86.6 120.9 154.4	10.3 14.4 18.4	Significant increase in cost of administering codes; significant increase in building trades employment and sales of building materials, i.e, insulation, storm windows	7	No appreciable effect	5	Increased comfort due to reduced infiltration, heat gains, heat loss	8	Probable rejection of added costs particularly among low and moderate income homeowners as well as business	3	Need to adopt retrofit code; increase in plan review and inspection staff; probable political opposition	1	Technology required readily available	10	Life cycle costs about the same or slightly lower	6	40	C
(C2) State Energy Code	Low Moderate High	.394 (a) .631 (a) .904 (a)	2.4 3.9 5.7	5.9 9.3 12.7	84.8 135.7 197.7	46.1 74.1 109.3	5.7 9.2 13.4	Some increase in cost of administering building code; some increase in sales of building materials, i.e., insulation, insulating glass	6	No appreciable effect	5	Increased comfort in new building due to reduced infiltration, heat gain, and heat loss	10	Definitely acceptable. costs already included in construction costs	10	Need to educate staff; additional plan review	9	Same as above	10	Life cycle costs significantly lower than business as usual	8	58	A
(C3) Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable		–	–	–	–	–	No appreciable effect	5	No effect	5	Increased comfort due to reduced infiltration, heat gain, and heat loss	10	Public acceptance depends upon degree of change and cost; probable limited opposition, generally	8	No major obstacles	8	No constraints anticipated at this time	10	Life cycle costs about the same as business as usual	5	51	B
(C4) Modified Housing Mix	Low Moderate High	.039 (b) .124 (b) .222 (b)	.41 1.3 2.3	.79 2.5 4.5	14.4 45.7 81.8	8.2 25.9 46.5	.98 3.1 5.6	No effect on employment or general revenue fund	5	No appreciable effect	5	Some reduction in privacy	7	Possible opposition to spatial distribution and staging of new multifamily units; changes in overall density	4	Probable opposition to rezoning; rezoning hearings required	4	Same as above	10	Life cycle costs somewhat lower than business as usual	6	41	C
(C5) Energy-Efficient Neighborhood Development	High Only	.900 (b)	540.0	7110.0	1170.0	45.0	117.0	Seen as more secure investment due to initial value and capability of projecting future value. Less subject to abrupt changes effecting property values	10	Reduction in demand for vehicle fuel in Riverside; no effect on reliability	5	Reduced dependence on auto; more leisurely environment; greater perception of personal safety; greater emphasis on preserving nature	10	Marketing of energy efficiency and new lifestyle could create a backlog of occupants; early possible opposition to development standards by builders	8	Some modifications and integration of C-1 and planned residential development (PRD) uses required; probable political opposition	6	Same as above	10	Life cycle costs significantly lower than business as usual	8	57	A
(C6) Planning Policy to Encourage Use of Passive Solar Building Design (Building Orientation)	No Direct Savings Attributable		–	–	–	–	–	No effect on employment. Increased building value over buildings with traditional orientation adding to municipal tax revenues	6	Some increase in supply stability due to use of alternative energy resource and some displacement	6	Reduction in variety of street layout	8	Possibly some opposition by builders/developers	9	Some difficulty in developing and adopting a solar-based zoning ordinance and revising subdivision code	4	No constraint	10	Life cycle costs somewhat lower than business as usual	6	49	B
(C7) Passive Solar Thermal Standard	Low Moderate High	.395 (b) .646 (b) .745 (b)	1.383 2.261 2.608	11.850 19.380 22.350	38.315 62.662 72.265	.237 .388 .447	2.370 3.876 4.470	Same as above	6	Slight increase in supply stability due to expected use of alternative energy resource and some displacement	6	Possible reduction in variety of building design; possible loss of living space	8	Increased property value should offset any opposition to design similarity or loss of space; probable builder opposition to standards	10	Same as above	4	Currently some limitations exist in efficient thermal storage; expected to be resolved before 2000	8	Life cycle costs about the same as business as usual	5	47	B
(C8) Passive Solar Cooling Standard	Low Moderate High	.276 (b) .416 (b) .540 (b)	5.0 7.5 9.7	.097 .146 .19	176.6 266.2 345.6	115.4 173.9 225.7	12.1 18.3 23.8	Same as above	6	No effect because electricity is generated outside the city and the city has no control over	5	Improved temperature control for the building and adjacent areas such as patios	10	Same as above	10	Same as above	4	Same as above	9	Life cycle costs somewhat lower than business as usual	6	50	B
(C9) Convert Incandescent Lights to High Pressure Sodium	Low Moderate High	.014 (b) .014 (b) .014 (b)	.50 .50 .50	.01 .01 .01	17.9 17.9 17.9	11.7 11.7 11.7	1.2 1.2 1.2	Some capital investment by city; some reduction in operating cost to City. No effect on employment	5	Same as above	5	Loss of warmth and intimacy due to change in lighting effect	5	No obstacles	10	No obstacles	10	Technology required readily available	10	Life cycle costs about the same or slightly higher than business as usual	4	49	B
(C10) Reduce Total Energy Demand in Street Lighting	Low Moderate High	.045 (b) .089 (b) .134 (b)	.81 1.60 2.41	.016 .031 .047	28.8 56.9 85.8	18.8 37.2 56.0	1.98 3.9 5.9	Capital investment required by City. No effect on employment	5	Same as above	5	Possible decrease in perception of safety	7	Possible negative response to reduced lighting levels	6	No obstacles	9	Same as above	10	Life cycle costs somewhat lower than business as usual	6	48	B
(C11) Education Program to Improve Efficiency of Industrial Processes and Operations	Low Moderate High	.740 (c) 1.095 (c) 1.443 (c)	.74 1.09 1.44	2.96 4.38 5.77	131.0 193.8 255.4	138.4 204.8 269.8	6.7 9.9 13.0	No appreciable effect	5	No appreciable effect	5	No effect	10	No obstacles	10	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	7	57	A
(C12) Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low Moderate High	.939 (d) 1.408 (d) 1.878 (d)	563.4 844.8 1126.8	7418.1 11123.2 14836.2	1220.7 1830.4 2441.4	47.0 70.4 93.9	122.1 183.0 244.1	Some decrease in tax income from fuels; savings realized by individuals	6	No effect	5	Less privacy in travel; fewer options in choice of vehicle size; contention with possible restrictions discouraging private autos	6	Low probability of acceptance due to resistance to change in use of private autos	2	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	8	47	B

TABLE ES-4. (Continued)

Options	Energy Savings: Impact	Energy Savings: Savings (BTU's x 10^{12})	Environmental Impact (Decrease in Emissions, lb x 10^3/yr): HC	CO	NO_x	SO_2	Particulates	Secondary Outcomes: Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Feasibility: Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value	Total All Values	Category
Supply																							
(S1) Solar Water and Space Heating	Low Moderate High	1.3 (f) 1.3 (f) 2.2 (f)	4.6 4.6 7.7	46. 46. 77.	127. 127. 216.	0.8 0.8 1.3	8. 8. 13.	Systems require variable investment depending on degree of service desired	6	Shifts reliance to nondepletable resource. Requires backup under normal conditions. Would be functional under upset conditions	7	Negligible	5	Excellent – may even override some degree of increased cost over next best alternative	10	No effect. Systems are currently being commercially installed	10	Commercial – Advancements offer hope of lower costs	10	Can be cost competitive with electric heat but probably not with natural gas. Will increase local trades employment	8	56	A
(S2) Investment in Remote Conventional Generating Plants, Coal/Nuclear	All	14.3 (i)	257.	5.	9152.	6000.	630.	Investment is variable depending on degree of service desired. Benefit is linear with investment	9	Shifts reliance to nonscarce resource. Highly dependable under normal conditions. Not dependable under upset conditions	7	Negligible	5	Public acceptance has had major impact on failure of previous projects such as Kaiparowits and Sundesert	6	Legal and institutional mechanisms already exist	10	Commercial – However, pollution control and waste disposal require development	8	Would result in lower cost of electric power for Riverside residents	10	55	A
(S3) Investment in Remote Nonconventional Generating Plants, Geothermal/Wind	All	14.3 (i)	257.	5.	9152.	6000.	630.	Same as above. Cost/benefit uncertain at this time	6	Shifts reliance to nonscarce or nondepletable resource. Dependability under normal and upset conditions needs to be proven	8	Negligible	5	Probably somewhat less negative than to S2 due to newness of technology	6	Could be handled under same agreement as S2. Some additional problems exist for geothermal	9	Noncommercial Both geothermal and wind will require development and economic demonstration	7	Would result in lower cost of power contingent on technology development	7	48	B
(S4) Integrated Utility System Based on Gasification of Coal and Refuse	Low Moderate High	8.7 (e) 10.5 (e) 12.8 (e)	150. 180. 200.	-100. -120. -140.	2500. 3000. 3700.	1000. 1200. 1600.	100. 120. 150.	Large investment required even for minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Less dependable than S2 under normal conditions – somewhat more dependable under upset conditions	7	Some temporary disruptive effect due to construction	4	Will depend largely on how effectively project can be sold to the public. Unlike S2 and S3 the people most affected by the plant are those who benefit from its service	5	Could be handled under same conditions as S2. Plant generator would need mechanism for sale of steam and chilled water	9	Noncommercial. Projected technology commercialization in late 1980's	7	Would result in lower cost of power contingent on technology development. Would increase local employment. Requires substantial initial investment	7	45	B
(S5) Hydrogen Production for Captive Vehicle Fleet	All	0.38 (j)	228.	3002.	494.	19.	49.	Moderate to large investment required. Benefit increases with investment	5	Shifts reliance to nonscarce resource. Increased dependability of fuel supply. Engine dependability needs demonstration	7	Negligible	5	Good for general public for environmental reasons. Poor for drivers and mechanics which could seriously affect success of project	5	No effect	10	Noncommercial. Both production and end use systems require development and demonstration	7	Negligible impact	5	44	B
(S6) Methane From Wastes. Landfill, Feedlot Manure, Sewage Sludge	All	0.2 (h)	Essentially No Change					Relatively small investment required	6	Shifts reliance to nondepletable resource. Dependability under normal and upset conditions lower than conventional natural gas	6	Negligible	5	Little or no public reaction expected	5	No effect. Systems are currently in commercial use in other locations	10	Commercial	8	Potentially lower cost of natural gas but probably negligible impact	5	45	B
(S7) Geothermal District Heating/Cooling	Low Moderate High	2.8 (g) 3.4 (g) 4.1 (g)	76. 93. 113.	58. 71. 87.	273. 333. 406.	1.7 2.1 2.6	17. 21. 26.	Large investment for even minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Dependability under normal conditions needs demonstration. Dependability under upset conditions somewhat higher than S2, S3, and S4	7	Some temporary disruptive effect due to construction	3	Somewhat more acceptable than S3	5	Plant operator would need mechanism for sale of hot water	9	Noncommercial. Possibilities depend highly on resource characteristics	3	May result in lower heating and cooling costs. Highly dependent on resource capacity and characteristics	7	40	C

For assumptions and detailed calculations, see
- (a) Volume 2, Appendix C1, Attachment C1-1.
- (b) Volume 2, Appendix C4, Attachment C4-1.
- (c) Volume 2, Appendix C2, Attachment C2-2.
- (d) Volume 2, Appendix C3, Attachment C3-1.
- (e) See Appendices D9-D10.
- (f) See Appendix D2.
- (g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
- (h) See Appendix D5.
- (i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
- (j) See Appendix C3, Attachment C3-1.



*The 100 percent figure is approximately equivalent to 43 x 10^{12} Btu/year or 7.2 x 10^6 barrels of oil per year.

FIGURE ES-1. EFFECT OF IMPLEMENTING SELECTED ENERGY SUPPLY AND CONSERVATION OPTIONS ON RIVERSIDE ENERGY USE IN THE YEAR 2000

Minimum Strategy/Low Impact - This bar represents the most likely mix of energy sources in the year 2000. The items in this bar appear to be most cost effective and easiest to implement based on current projections. They include:

Conservation - All the items in Category A in Tables ES-2, ES-3, and ES-4.

Solar - Domestic hot water heating only. 30 percent implementation in existing single family residences and 70 percent in new single family residences.

Remote Electric investment in San Onofre 1.8 percent, Intermountain Power 6 percent, and Palo Verde 1 percent.

Purchased Electric - Approximately 38 percent of Riverside's electric needs purchased from utilities.

Natural Gas and Oil - Still purchased as in Business as Usual case.

Moderate Strategy/Moderate Impact - This bar includes items that may prove to be cost effective and beneficial to implement by the year 2000. However, they are generally more difficult to implement or require more rapid technology development than can be projected at this time. They include:

Conservation - All items in Categories A and B from Tables ES-2, ES-3, and ES-4.

Solar - Domestic hot water heating only. 50 percent implementation in existing residences and 100 percent in new residences.

Integrated Utility System serves census tracts 303, 304, 305, and 422.03 with steam and chilled water. Also generates about 30 percent of Riverside's electric needs. Efficiency gain represents net fuel savings as a result at the co-generation of steam and electricity. Coal and refuse are converted to a gaseous fuel for use in the plant.

Remote electric investment in remote plants may include some geothermal sources. Total remote investment reduced from previous case to satisfying about 32 percent of Riverside's electric needs.

Methane recovers through anaerobic digestion of feedlot manure and refuse as a direct replacement for natural gas.

Purchased electric maintained at about 38 percent of Riverside's electric needs as in previous base.

Hydrogen produced from electrolysis of water used in portion of Riverside captive vehicle fleet.

Natural gas and oil still purchased as in Business as Usual.

Maximum Strategy/High Impact - This bar differs from the previous bar primarily in degree of implementation although some conservation items are added. This bar includes:

Conservation - All items listed under conservation in Tables ES-2, ES-3, and ES-4.

Solar - Domestic hot water and space heating. 70 percent implementation in existing residences and 100 percent in new residences.

Integrated Utility System expanded version of previous case serving census tracts 303, 304, 305, 422.03, 422.02, 307, and 311. Plant uses refuse and coal as source of gaseous fuel and generates about 41 percent of Riverside's electric needs.

Remote electric - Approximately the same as in the minimum strategy.

Methane Recovery - same as in previous case.

Purchased electric - This case assumes that Riverside would be responsible for all of its own electric needs and no purchased electric would be required.

Hydrogen - same as in previous case only expanded to entire captive vehicle fleet.

Natural gas and oil still purchased as in Business as Usual.

Expected Benefits

Expected benefits in the year 2000 from implementation of the recommended maximum alternative energy strategy and Action Plan are:

- A high degree of reliability of energy supply based on conservation and alternative energy supply sources including coal, refuse, solar, and hydrogen in addition to natural gas and oil.
- Reduced total energy costs to the consumer based on the projected cost of energy to the year 2000.
- A reduced dependence on electric utility power because of in-community generation capability.
- A minimum risk, because of the use of proven technology.

FINAL REPORT

on

PHASE I. INTEGRATED COMMUNITY ENERGY PLAN FOR RIVERSIDE, CALIFORNIA CONTRACT W-7405-ENG-92, TASK 100

to

U.S. DEPARTMENT OF ENERGY
OFFICE OF ASSISTANT SECRETARY FOR ENVIRONMENT
OFFICE OF TECHNOLOGY
DIVISION OF REGIONAL ASSESSMENTS
OFFICE OF ASSISTANT SECRETARY FOR CONSERVATION AND SOLAR APPLICATIONS
DIVISION OF BUILDINGS AND COMMUNITY SYSTEMS

January, 1979

BATTELLE
Columbus Laboratories
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INTRODUCTION

The United States in the past 5 to 10 years has acquired a new awareness of its sources of energy supply and how energy is used to supply the many needs of the American people. This awareness was precipitated by a number of factors. Two of the major factors are (1) difficulties in meeting demands for natural gas which have resulted in limitations on new users and curtailments to some existing users, and (2) the Arab oil embargo of 1973 which accented the tenuous posture of the United States' ever increasing dependence on foreign oil imports and caused a drastic increase in the price of oil. The latter is still today causing major imbalances in the American economic system.

In 1977 the United States was about 75 percent dependent on natural gas and oil for its energy needs. Today, about half of our oil is imported from foreign countries, whereas in 1973, the year of the embargo, only about one-third was imported.

Undoubtedly, higher prices for both natural gas and oil will stimulate new discoveries, however, these new supplies will be even more expensive than those which we are now consuming.

The problems that the United States faces as a result of its dependence on natural gas and oil are chronic. New supplies will be increasingly more difficult to obtain and their cost will continue to rise.

Thus, government officials at nearly all levels are faced with the formidable task of developing plans and policies that will stimulate conservation, the increased discovery of new domestic natural gas and oil reserves, as well as a shift to the use of renewable energy sources to meet a portion of our future energy needs. To facilitate the planning process it is important to know and understand the needs for energy at the community level and what options are available for meeting these needs. Specifically, information is needed to define:

1) What are the needs for energy within a community?
2) How can these needs be affected by conservation and changes in community design to enhance energy utilization efficiency?
3) What options are available to a community to shift to more stable, plentiful energy resources?
4) What activities or policies can stimulate implementation of options for conservation and use of nonscarce energy resources? What roles can various government bodies (local, State and Federal) and community groups play in implementation?
5) How will implementation of conservation and alternative energy supply options affect the environment and lifestyle within the community?
6) How can interaction be achieved between the general public and the energy planning, policy making process in order to achieve energy policies that are sensitive to the needs of the people and most efficient in meeting them?

This study addresses these questions for the Community of Riverside, California. Riverside is in the heart of Southern California and is typical of many communities in the Southwest. The Southern California area is one of the major population centers of the United States, is nearly 90 percent reliant on natural gas and oil for its energy needs, and has an especially sensitive balance between environment and the ways in which energy needs are met. Southern California has, in many ways, led the rest of the country in seeking ways to minimize the environmental impact of energy utilization.

These needs coupled with strong local support in Riverside along with the interest of California Energy Resources Conservation and Development Commission were matched with the plans of the U.S. Department of Energy (DOE) to support a program for studying the development of an integrated community energy plan for the City of Riverside.

The U.S. Department of Energy initiated the program by awarding a Phase I contract for research services to Battelle's Columbus Division in July, 1977. To date, the research appropriation has totaled $326,000.

OBJECTIVES AND SCOPE

The primary objective was to develop an integrated community energy plan for the City of Riverside. Basic subobjectives for the Phase I Program were to:

- Perform a general energy audit of the City of Riverside, develop demand profiles, and make projections of energy use to the year 2000.
- Select alternative energy strategies combining conservation options and available alternative energy options that will fulfill requirements of decreasing the use of scarce fossil fuels, increase energy stability, and reduce locally generated environmental pollution.
- Present the final results in a written report and a public conference in Riverside.
- Evolve methodologies and policies for working with local, County, regional, State, and Federal institutions on integrated energy/environmental problems.

Within the scope of this program, considerable site-specific baseline data on present energy use, energy conservation opportunities, alternative energy resources and systems, environmental conditions and intergovernmental relationships and policies were collected or developed. These data were used in an integration methodology to identify/recommend viable alternative energy strategies and to develop a set of recommended Action Plans--minimum, moderate, maximum effort--aimed at reducing Riverside's dependence on scarce fossil fuels. The integration methodology provided for a mixture of energy conservation options and alternative energy options from the present to the year 2000 for each energy strategy recommended. All of the baseline data generated during this study should provide a proper data base for decision making and, combined with the recommended energy strategies, should be of immediate use to the City of Riverside planners as well as to those of the County and State. For example, air pollution in the City of Riverside is produced in many communities within California's South Coast Air Basin and carried to Riverside on prevailing air currents. Even though providing Riverside with an energy plan that reduces pollution will do little to alleviate local air pollution. However, Riverside's plan can be a model for other communities, which in turn can serve to improve air quality in the South Coast Air Basin.

Methodology development that would be useful as a model for other communities was also a major concern in the program.

METHODOLOGY

Development of an integrated community energy plan is a complex undertaking and requires a methodology capable of incorporating a host of technological, socioeconomic, and institutional considerations. Figure 1 shows, schematically, the key elements identified by Battelle in developing the integrated community energy plan for Riverside.

The specific methodology utilized in this study is outlined as follows:

(1) Collect or develop baseline data on the following:

- Riverside Energy Consumption Patterns
- Energy Conservation Activities in Buildings, Community Design, Transportation and Industry
- Energy Supply Options Including Coal, Solar, Geothermal, Waste-to-Energy, Biomass, and Wind
- Existing Environmental Conditions
- Legal/Institutional Factors
- Public Acceptance (Education) Programs,

(2) Develop three population growth scenarios-low, moderate, and high-for the year 2000. These forecasts were derived from historical trends in birth, death, and migration rates, modified by estimates of the growth management planning and policies of Riverside.

(3) Project total and sectoral energy demand profiles to the year 2000.

(4) Identify energy conservation opportunities in buildings, community design, transportation, and industry and estimate energy savings in terms of a low, moderate or high strategy.

(5) Identify alternative energy supply options and evaluate each to determine the volume of resources potentially available to Riverside, their development costs, and their environmental impacts.

(6) Recommend a series of alternative energy strategies which include conservation and alternative energy supply options.

(7) Estimate the primary outcome of each strategy--the degree of energy independence and reduction in consumption of scarce fossil fuels.

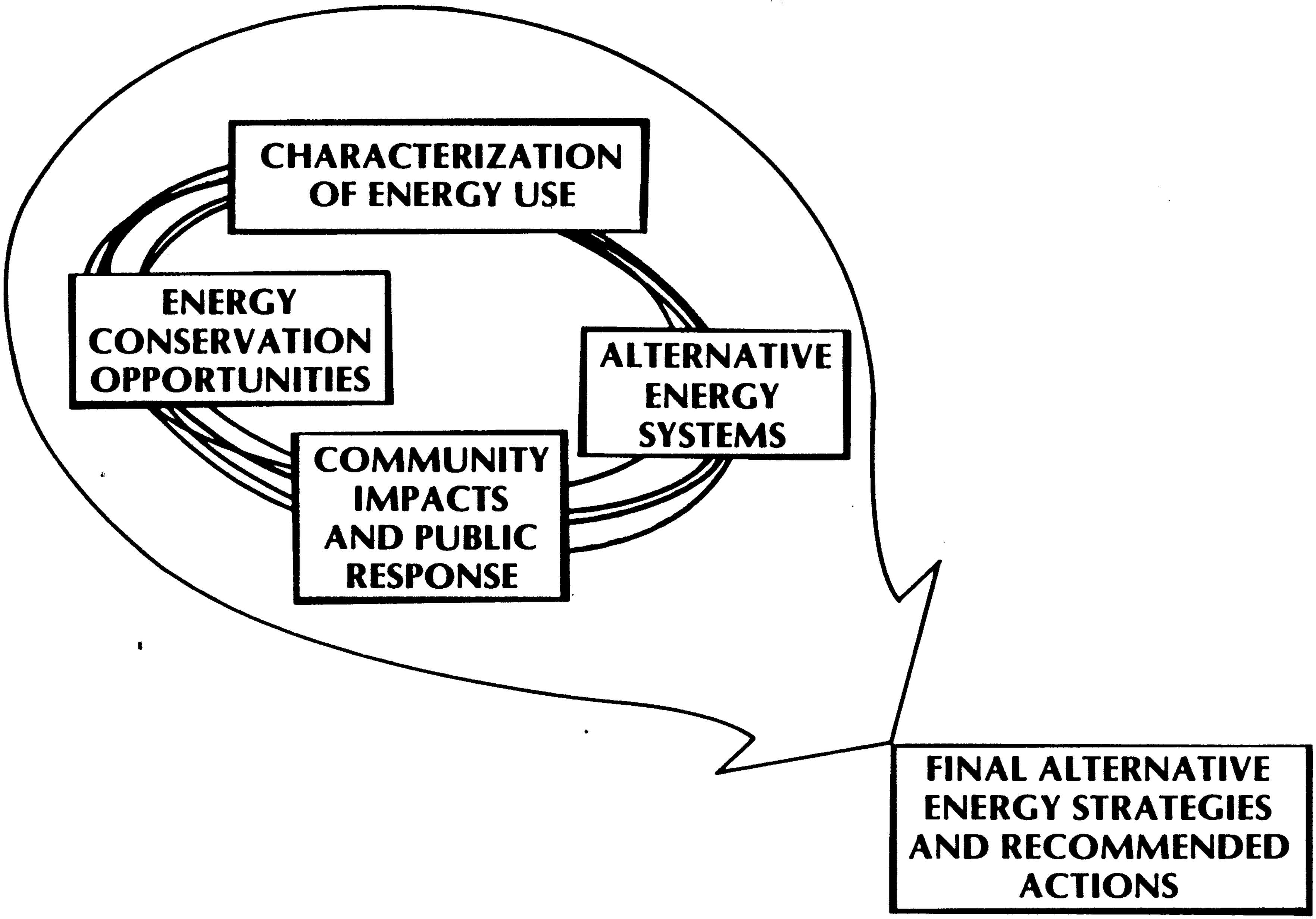


FIGURE 1. KEY ELEMENTS IN DEVELOPING AN INTEGRATED COMMUNITY ENERGY PLAN

(8) Analyze the secondary outcomes in terms of the impact of each strategy on health/pollution, local economy, energy supply stability, and lifestyle.

(9) Analyze the feasibility of each strategy in terms of public acceptance, legal/institutional constraints, technological constraints, and public and private sector costs.

(10) Formulate an action plan and time schedule for each strategy during the time period 1978-2000.

A team approach was used to perform the various tasks (i.e., energy audit, conservation, alternative supply) required to obtain the baseline information. The detailed analyses of each of these tasks are presented in the Appendices to this report and are included in Volumes II and III.

No community energy plan can be developed or implemented without extensive community involvement. Although the Phase I Program was heavily oriented toward performing technical analyses because of the need for site-specific data, and toward conducting an energy audit and designing a methodology, substantial community involvement did occur. This included:

- Close interaction with the Riverside Public Utilities Department, especially with the Public Utilities Director and the Energy Coordinator appointed to interface with the Phase I Program.
- Working throughout the Program with an Advisory Committee composed of City of Riverside officials and citizens, and representatives of the California State Energy Commission, University of California-Riverside (UCR), and the U.S. Department of Energy.
- Numerous personal contacts with City/County/State/Regional/Federal officials; representatives of business, industry, universities, planners, builders, utilities, and private citizens to obtain data and discuss ideas.
- Presentations to various community groups and the provision of information on the background, scope and progress of the Program for general news purposes.

The excellent cooperation received from all the Riverside contacts demonstrated the high degree of local interest in this Program and will contribute significantly to ensuring the community's capability in carrying this energy planning phase into the implementation phases. Appendix H presents the background and details of the various community involvement activities during the Phase I Program.

In the latter part of the Phase I Program, the Advisory Committee recommended taking aerial infrared photographs of Riverside. The photos will be used by the City of Riverside Public Utilities Department, the Riverside Chamber of Commerce, and the Southern California Gas Company in Riverside for an energy public awareness program. This effort was not within the scope of the Phase I Program, and U.S. DOE funded and contracted with a specialized firm for this photography. However, since the infrared photography was an outgrowth of the activities of the Phase I Program, it is presented as part of this report (Appendix I). A more detailed description of the overall program is included in Appendix I.

FINDINGS

Using the methodology described in the preceding section, specific findings resulted from the Phase I Program. The findings are presented in this section in the following order:

- Baseline Information. The current status of Riverside relative to energy consumption patterns in buildings, transportation, and industry is presented along with various conservation activities, population growth projections, alternative energy supply options, environmental conditions, legal/institutional factors, and public acceptance (education) programs.
- Business-as-Usual Projections. The energy requirements for Riverside are projected to the year 2000 on a business-as-usual basis. The primary assumption is that the energy requirements of the community will grow in direct proportion to the population growth in the community. Also, the projections are made assuming that there will be no additionally significant conservation measures introduced and that no drastic changes in lifestyle will occur in Riverside by the year 2000.
- Options. Potential energy conservation and alternative energy supply options applicable to Riverside are discussed. Generally, the options presented include only those over which the City of Riverside could have direct control. In identifying these options, it was also assumed that the City would continue to be in the utilities business, although it was recognized that the City is capable of managing or participating in the management of either centralized or decentralized energy production systems.
- Screening of Options. The methodology used by Battelle to screen the universe of options is described along with a ranking of the top options that were selected to be analyzed in greater detail.

- Evaluation of Selected Options. The primary and secondary outcomes, as well as the feasibility of each option are analyzed. Primary outcomes concern (1) how the business-as-usual energy demand in the year 2000 is decreased by energy conservation and (2) how the reduced demand in the year 2000 is met by a combination of conventional and alternative supply options. Secondary outcomes are an evaluation of the secondary impacts (health/pollution, local economy, energy supply stability, lifestyle) and the feasibility (public acceptance, legal/institutional, technological availability, public/private sector costs) associated with implementation of the conservation and alternative energy supply options.
- Selection of Alternative Energy Strategies. A set of three alternative energy strategies--minimum, moderate, maximum effort--are delineated for the City of Riverside. The methodology used to select the various conservation and alternative energy supply options is shown and discussed.

BASELINE INFORMATION

Baseline information was developed for the Riverside community. Collection of this information was necessary so that in subsequent analyses, as energy conservation and alternative energy options are considered, appropriate technologies, programs and incentives may be properly integrated with the energy requirements, existing supply systems, and ongoing programs to provide balanced site-specific recommendations. Specifically, baseline information was developed for the following categories:

- Geographic Location, Subdivisions, and Development Patterns
- Weather Conditions - local climate
- Historical and Current Energy Use - by fuel type and end uses, segregated by City census tracts
- Stationary Energy Consumers - residential, commercial, and industrial
- Current Energy Conservation Activities - buildings, community design, and industry
- Indigenous Alternative Energy Resources
- Transportation - characterization of vehicle population and available options
- Legal/Institutional Environment - a description of public sector institutions which most directly impact energy development in Riverside
- Environmental Quality - historical, current, and future trends
- Energy Conservation Education.

Details of the data developed in each area are presented in Appendices B, C, D, E, F, and G. The following sections summarize the baseline information developed in each of the above listed categories.

Geographic Location, Subdivisions, and Development Patterns

Geographic Location and Subdivisions

Figure 2 shows the location of Riverside in Southern California. The City is located 53 miles east of Los Angeles and it covers an area of 72.4 square miles, an area greater than that of either San Francisco or Manhattan Island.(1)

Figure 3 is a close-up of the City itself. The heavy lines delineate the subcommunity boundaries, the names of which appear on the map. The finer lines within the subcommunities outline the census tracts within the City.(2) Some subcommunities contain many census tracts, such as Arlanza-La Sierra, while others constitute a single census tract, such as Mountain View. It was found that the census tract subdivisions within the Community of Riverside provided for a reasonable distribution of the energy analysis to subsections of the community. The census tracts, therefore, were convenient building blocks with which to establish the energy consumption patterns of Riverside as a whole, as well as establishing the distribution of the energy consumption patterns within the community. Additional subdivisions of the energy consumption were obtained by separating each census tract into the three consuming sectors: residential, commercial, and industrial.

Development Patterns

Land area within the City of Riverside is currently about 50 percent developed, with the remaining portions either vacant or devoted to agricultural production. Residential use occupies the major portion of developed land. Figure 4 shows that in 1975 residential use occupied approximately 60 percent of the developed land area within the City, or about 30 percent of the total area. The second largest land uses are public and institutional, which occupied approximately 13 percent of the developed area, or about 6 percent of the total City area. Commerical and industrial occupied approximately 12 percent of the developed area.

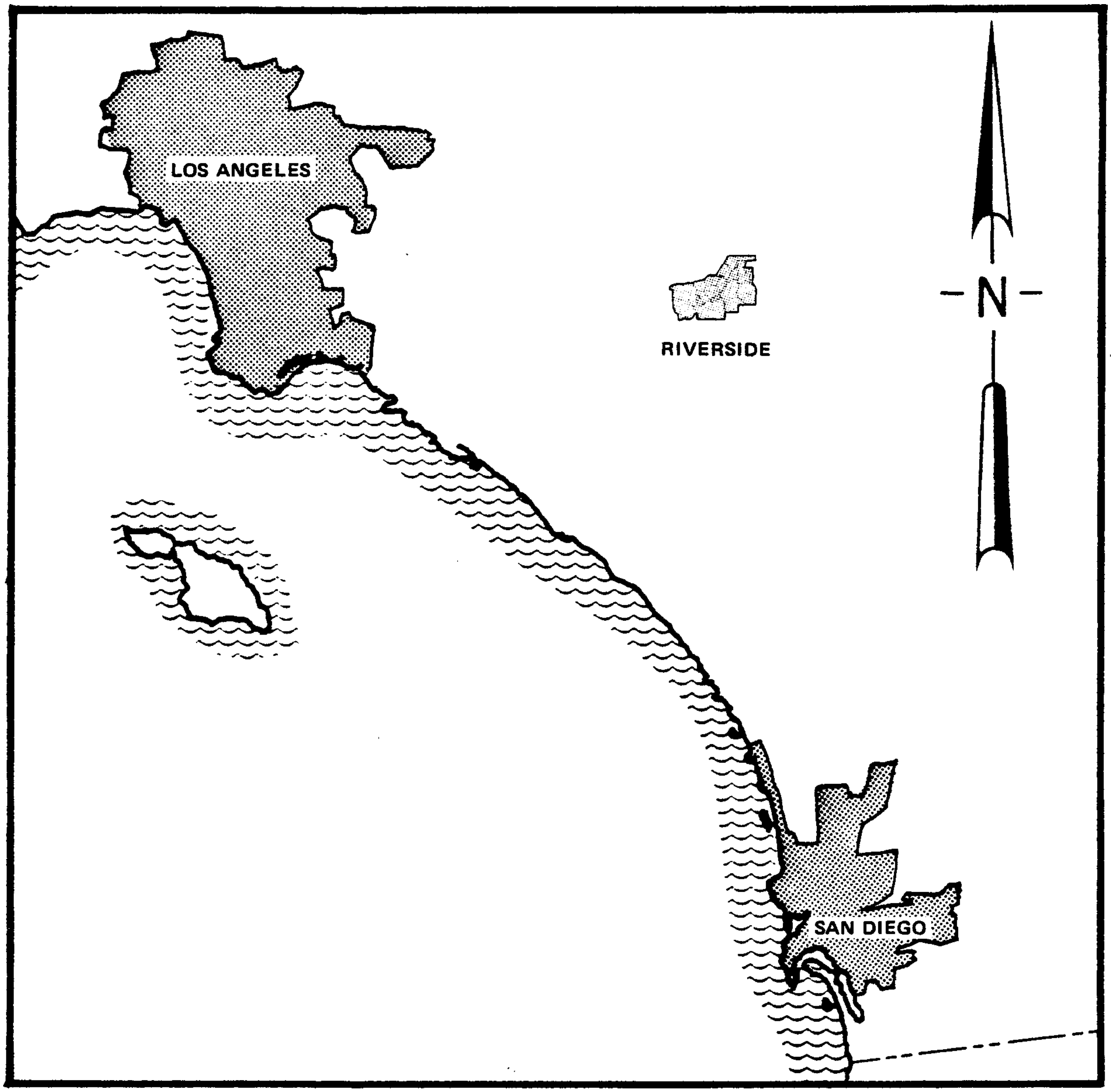


FIGURE 2. MAP OF SOUTHERN CALIFORNIA

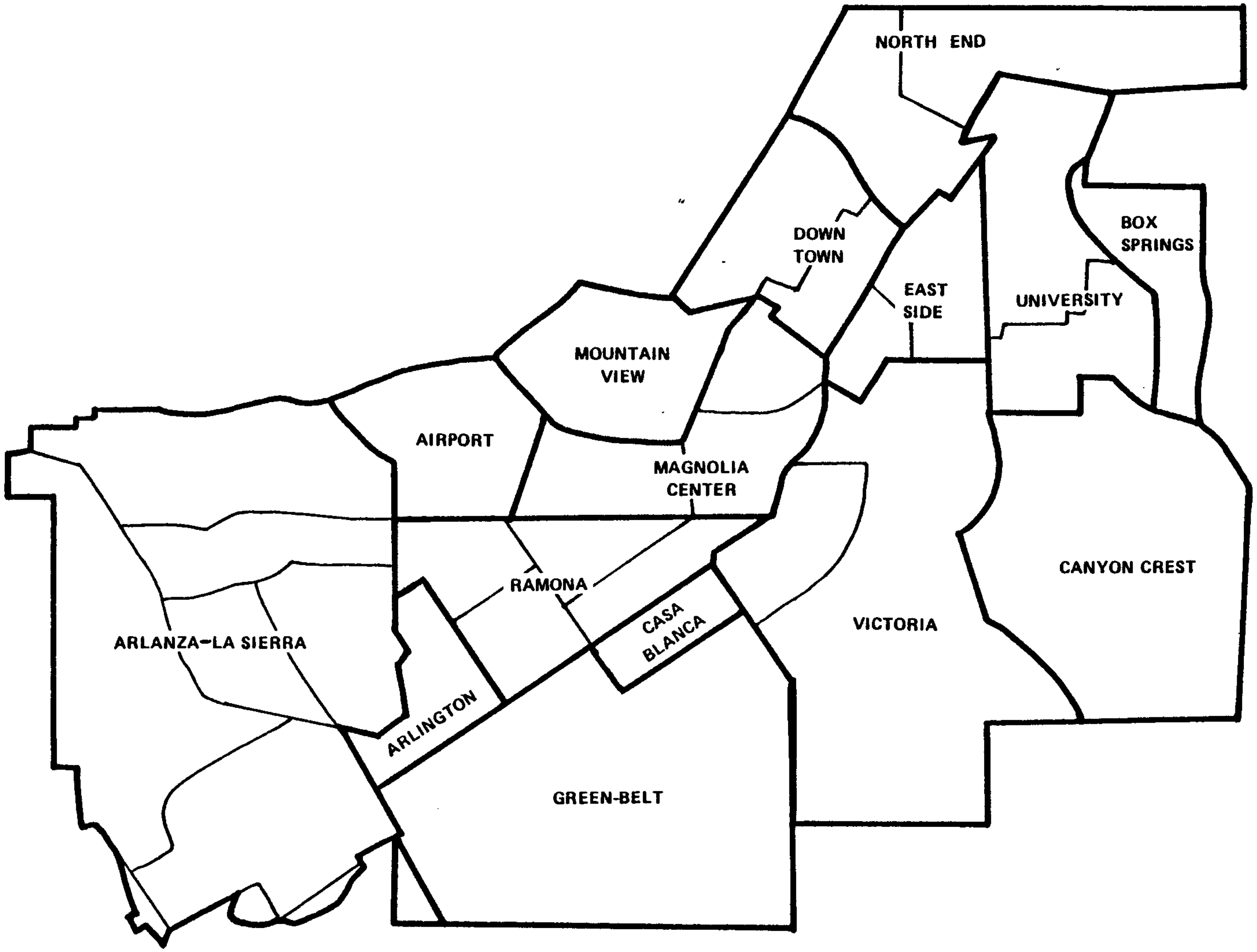


FIGURE 3. RIVERSIDE CALIFORNIA--SUBCOMMUNITIES

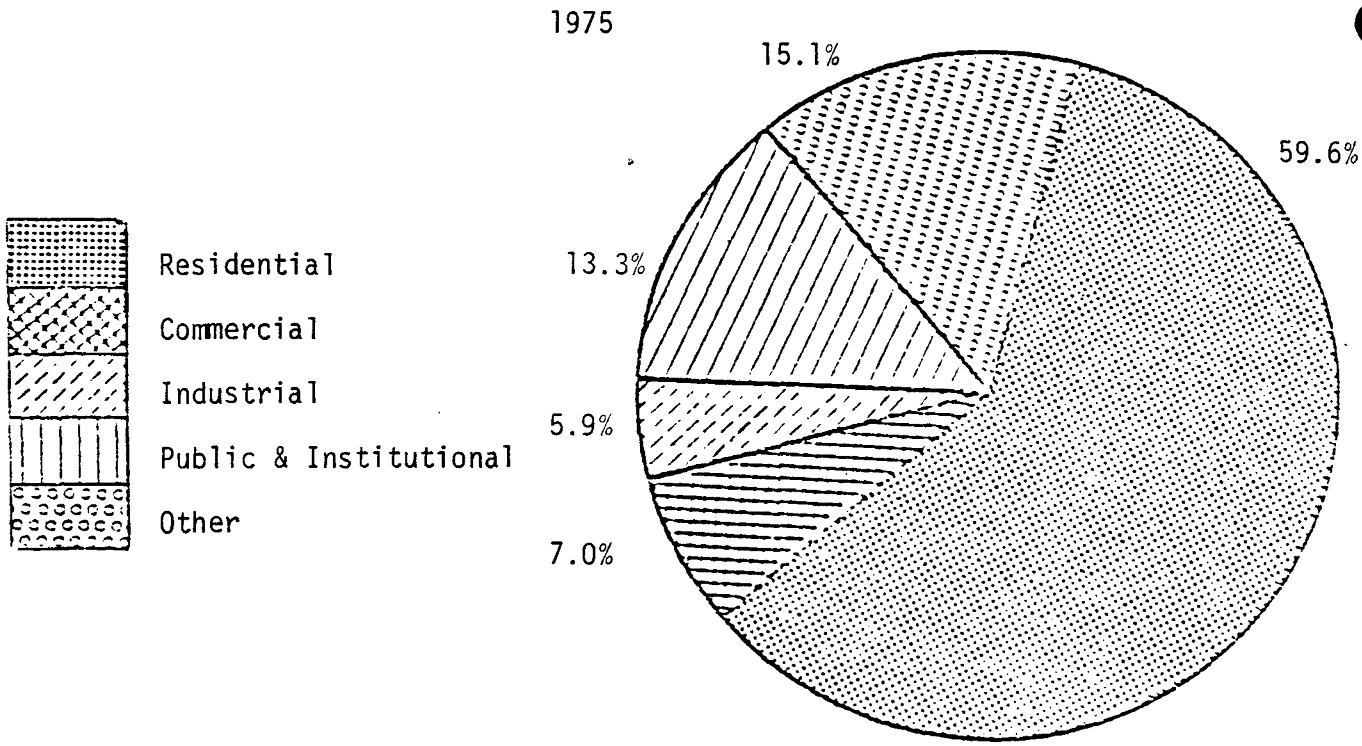


FIGURE 4. RIVERSIDE DEVELOPMENT PATTERN 1975

Source: Economic Basic Report, City of Riverside, July, 1977, Wilsey and Hamm.

The housing mix in Riverside as of mid-1977 is estimated as follows:

	No. of Units	% of Total
Single-family detached	45,200	75.6
Multifamily	12,400	20.7
duplex	1,922	3.2
low rise	9,052	15.1
high rise	1,426	2.4
Mobile homes	2,200	3.7
	59,800	100.0

A comparison of Riverside's present land use pattern with that of 1966 indicates the most dramatic increase has been in residential acreage. Public and institutional comprised 16 percent of the developed land area while commercial and industrial covered about 6 percent (Figure 5).

Weather Conditions

The local climate of a region is one of the major contributing factors to the patterns of energy consumption. Space conditioning requirements, i.e., heating and cooling, are normally the largest single contributing factor to energy consumption in the residential and commercial consuming sectors.

Table 1 presents the energy-related weather parameters for Riverside.[3,4,5,6] The Design Temperatures were established by the American Society of Heating Refrigeration and Air Conditioning Engineers according to the long-term climatic conditions that have been experienced in Riverside. These are the extremes over which any heating and cooling system should be designed to operate. Degree Days are a measure of the amount of heating or cooling that is required; they are defined as the difference between the average daily temperature (TAVE) and a base temperature of 65 F:

$$\text{Heating Degree Days} = (65 - \text{Tave}) \quad \text{if Tave} < 65$$

$$\text{Cooling Degree Days} = (\text{Tave} - 65) \quad \text{if Tave} > 65.$$

Table 2 lists a representative sample of the monthly conditions in Riverside.[7]

Historical and Current Energy Use

In order to establish the energy consumption pattern of Riverside, analyses were made of the historical energy consumption in the community in regard to: annual consumption, monthly and seasonal consumption, and peak hourly demands for energy.

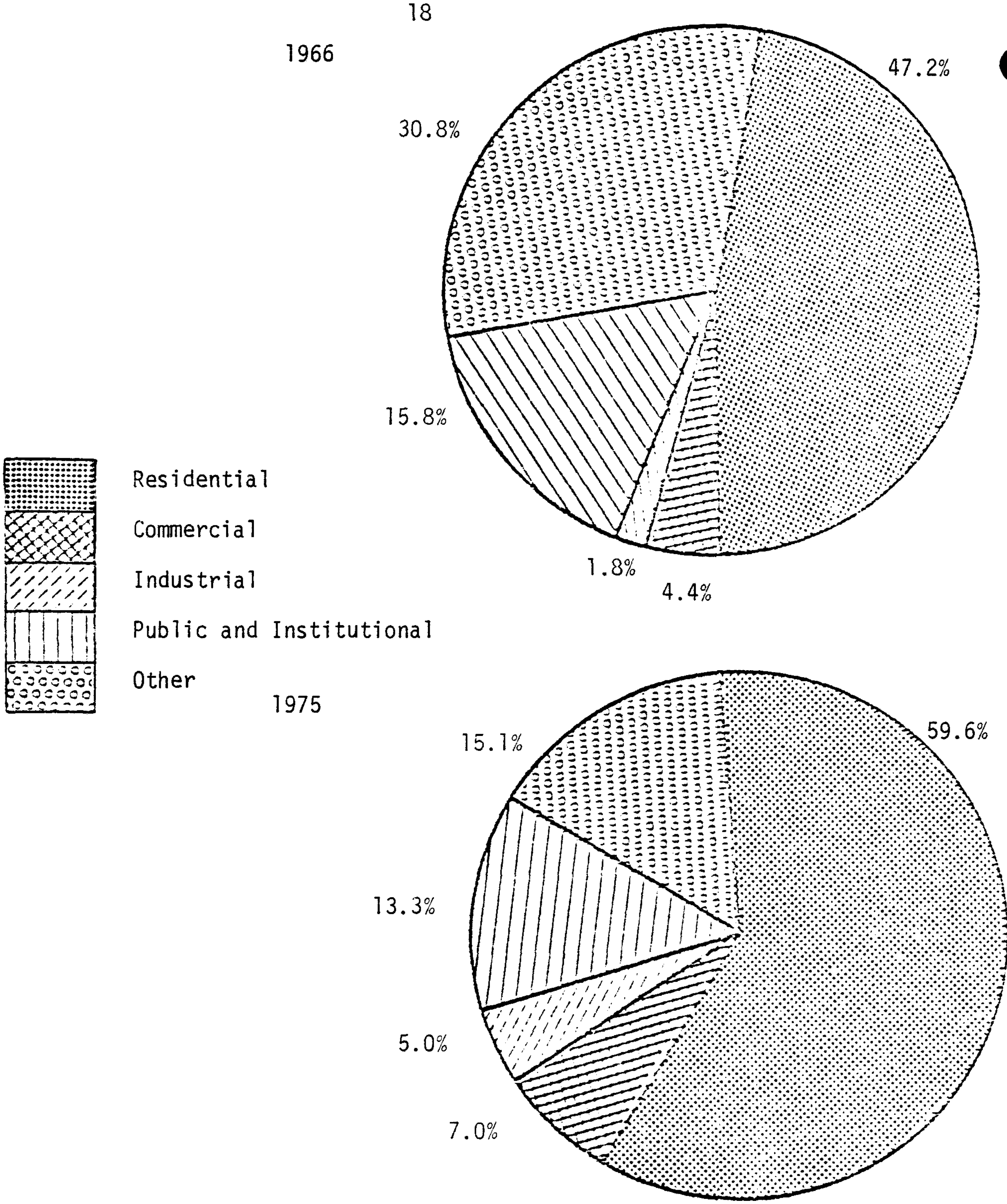


FIGURE 5. RIVERSIDE DEVELOPMENT PATTERN 1966-1975

Source: Economic Base Report, City of Riverside, July, 1977, Wilsey and Ham.

TABLE 1. WEATHER CONDITIONS--RIVERSIDE, CALIFORNIA

Winter Design Temperature	34 F
Summer Design Temperatures	
Dry Bulb	96 F
Wet Bulb	71 F
Annual Heating Degree Days	1920 F-Day
Annual Cooling Degree Days	1590 F-Day

	Percentage of Annual Degree Days	
Month	Heating	Cooling
January	28	0
February	25	0
March	22	0
April	0	0
May	0	5
June	0	13
July	0	27
August	0	27
September	0	20
October	0	8
November	0	0
December	25	0

TABLE 2. CLIMATE--RIVERSIDE, CALIFORNIA

	AVERAGE TEMPERATURE, F			RAIN	HUMIDITY		
Period	Min.	Mean	Max.	Inches	4 A.M.	Noon	4 P.M.
January	37.0	51.0	65.2	1.70	55	40	55
April	45.7	60.5	75.2	.91	60	30	50
July	57.0	75.5	93.9	.01	45	40	35
October	48.4	65.8	83.1	.60	50	30	40
Year	46.8	62.9	79.0	11.96	52	37	45

PREVAILING WINDS
NW

Mean Hourly Speed:
10-12 m.p.h.

SOURCE:
National Weather Service

Sources of Energy

The census data[7] indicated that over 98 percent of the major energy-consuming appliances in the residential sector (exclusive of transportation) use electricity or natural gas. The remaining two percent use sources such as bottled gas, heating oil, and wood. The commercial and industrial sectors likewise use the same two energy sources as their primary fuels. The natural gas consumers who are on an interruptible contract[8] will switch to alternative fuels (LPG or oil) when service is curtailed, but the primary fuel is natural gas. Of those industrial customers who responded to an energy survey conducted as part of this task,[9] there was no one customer whose propane or fuel oil consumption exceeded 1 percent of their natural gas consumption, on a Btu basis.

Table 3 displays the distribution of energy sources within each of the following residential consumption categories: space heating, water heating, and cooling.

No electric generation takes place within the City limits of Riverside. The City's Public Utilities Department (PUD) purchases electricity from Southern California Edison Company (SCEC) and Nevada Power Company and resells it to the customers in the City. The City is currently considering the purchase of fractions of various baseload generating facilities both in and out of California which is expected to yield a lower cost of power than that purchased from utilities. This was treated as one of the options of this study.

Electricity and natural gas comprise such an overwhelming percentage of Riverside's total energy consumption (exclusive of transportation) that the results presented below for the energy consumption patterns of the two main sources of energy provide a great deal of information regarding the energy consumption characteristics of this community.

Annual Consumption

Figure 6 presents the annual growth in energy consumption in Riverside for both electricity and natural gas.[10,11,12]

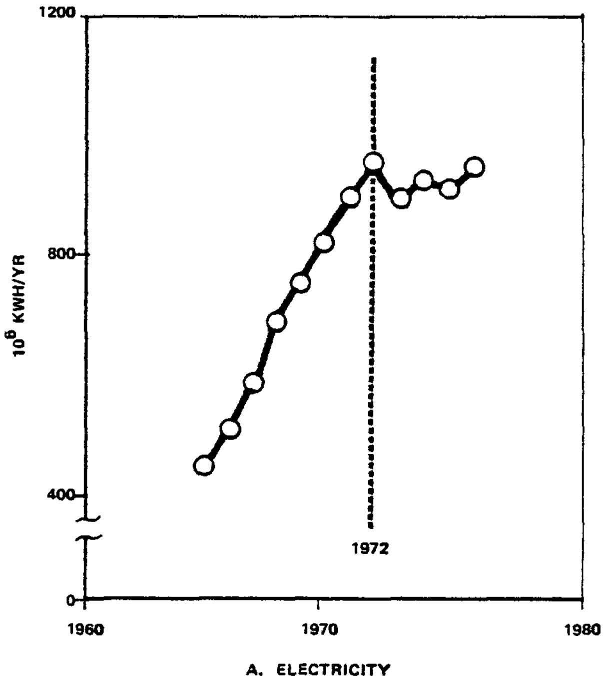
TABLE 3. RESIDENTIAL FUELS FOR RIVERSIDE (1970 CENSUS)

	Percentage of Dwelling Units		
Fuel	Space Heating	Water Heating	Cooling
Natural Gas	92.8	94.8	71.7
Electricity	5.2	3.9	27.2
Bottled Gas	1.0	1.0	0.7
Oil	0.5	0.1	0.1
Wood	0.3	0.0	0.1
None	0.2	0.2	0.2

During the period from 1968 to 1972, electrical energy consumption was growing at a rate of 8.2 percent per year. After 1972, growth in electrical consumption was drastically altered, so that the consumption through 1976 has yet to surpass the record 1972 consumption of 936 x 10^6 kwhr.

Growth in natural gas consumption, although not as dramatic as the electrical consumption growth prior to 1972, was more drastically altered during the years following 1972. During the years from 1968 to 1971, natural gas consumption was growing at a rate of 4.7 percent per year. The tabulation below shows the effects of weather on the annual consumption of natural gas. The dip that occurred in 1972 was primarily due to the abnormally warm winter that occurred during that year.

	1972	1973	Normal
Heating Degree Days, F-Day	1,685	2,003	1,920
Natural Gas Consumption, 10^6 cu ft	7.7	8.2	-----



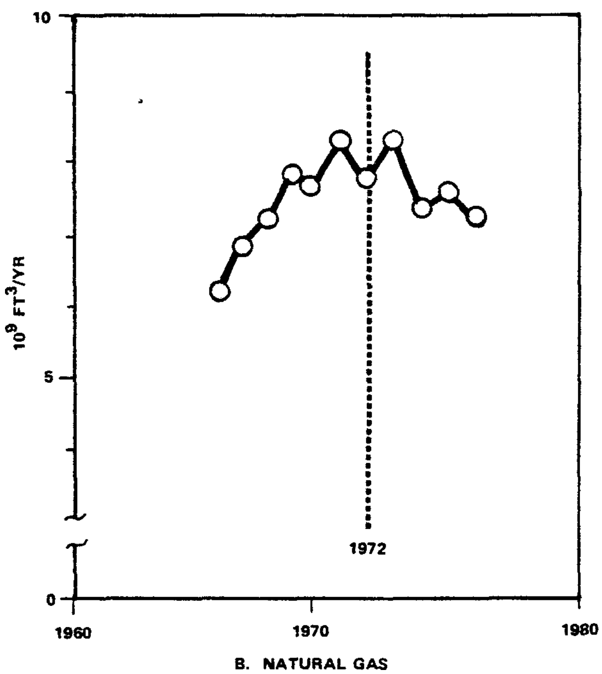


FIGURE 6. ANNUAL GROWTH IN ENERGY CONSUMPTION

In 1972, the number of heating degree days was 16 percent less than that in 1973, while consumption was 6 percent less. Space heating requirements constitute roughly 40 percent of all natural gas consumption. Therefore, adjusting the 1972 space heating consumption to 1973 heating degree day levels results in an adjusted 1972 consumption of $.6(7.7) + .4(7.7) \times (2003/1685) = 8.3 \times 10^6$ cu ft. Thus the dip that occurred in 1972 may be attributable primarily to the warm winter during that year. The consumption patterns following 1972 however, cannot be attributed to the weather since near normal conditions existed through 1975.

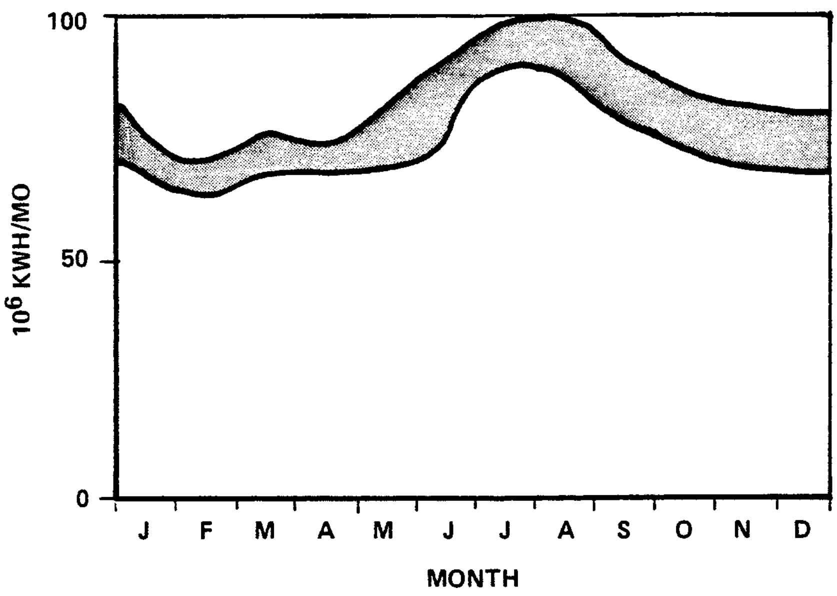
The relative impact of the energy crisis on energy consumption in Riverside in conjunction with the economic recession in the years following 1972 is very impressive. However, more detailed information was required since annual consumption was too gross a measure of energy consumption for the alternative energy system analysis.

Monthly Consumption

Figure 7 represents the monthly variations in electrical and natural gas consumption for all of the consuming sectors within Riverside: residential, commercial, industrial, and other. The band in each figure bounds all of the data points that were plotted. These represent all of the years following 1972. As observed from the annual consumption figures, this was the time period over which energy consumption remained relatively constant on an annual basis. Variations between individual months because of the weather, billing schedules, production schedules, and other factors are responsible for the width of the bands that appear on these figures. The variation over the course of the year is primarily a weather-dependent phenomena.

Peak Demands

Table 4 presents peak demands for energy in each of the three consuming sectors in Riverside.[13] These demands represent diversified demands. Not every consumer within a consuming sector requires energy at the exact same instant; thus the observed demands are not the simple sum of each individual customer's demand.



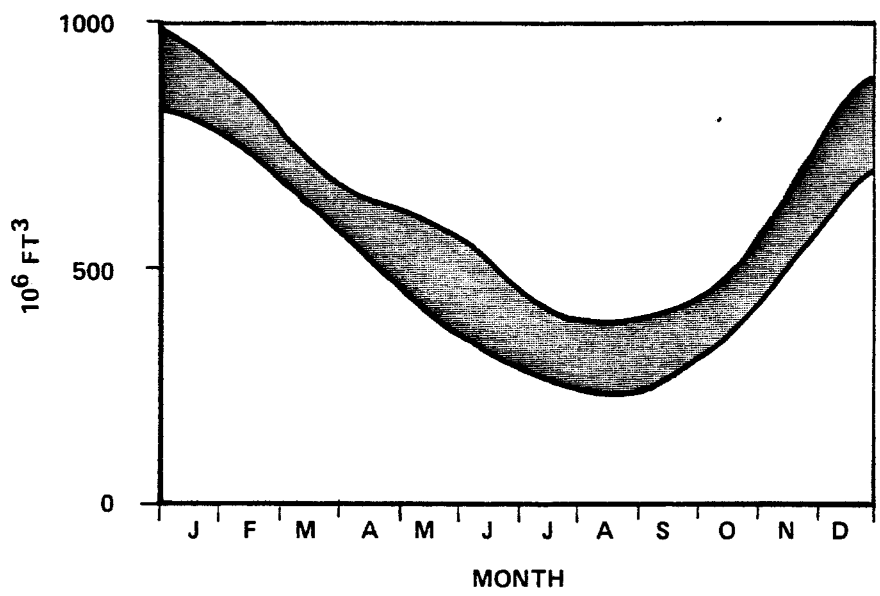


FIGURE 7. MONTHLY VARIATIONS IN ENERGY CONSUMPTION-BANDS REPRESENT COMPOSITE OF ALL YEARLY ENERGY USE FROM 1972 THROUGH 1976

TABLE 4. PEAK ENERGY DEMANDS (1976)

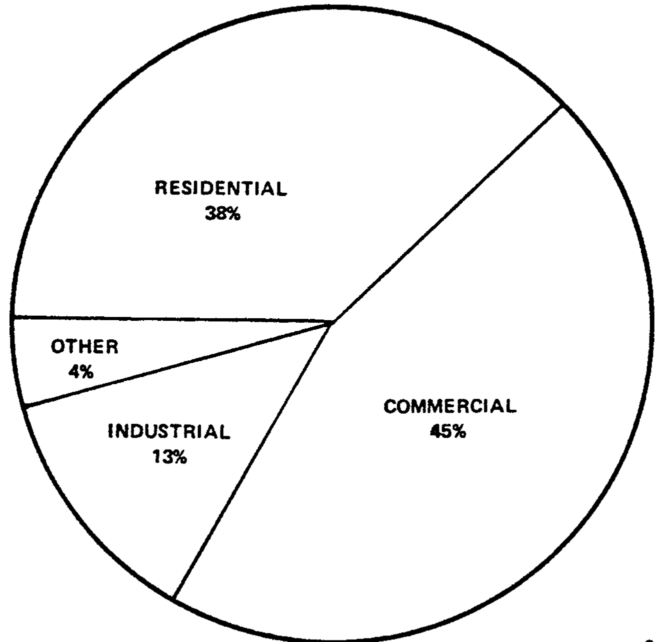
	Peak Thermal Demand, 10^6 Btuh	Peak Electrical Demand, MW
Residential Component	1320	121
Commercial Component	380	85
Industrial Component	290	44
TOTAL OBSERVED DEMAND	1990	250

The peak demands play an important part in the sizing of alternative energy systems for a community. The system must not only be able to match the performance necessary or meet the requirements of annual and monthly consumption, but it must also be able to handle the instantaneous demands placed on it by the community. The peak demands thus aid in this aspect of sizing the alternative energy systems.

Energy Distribution

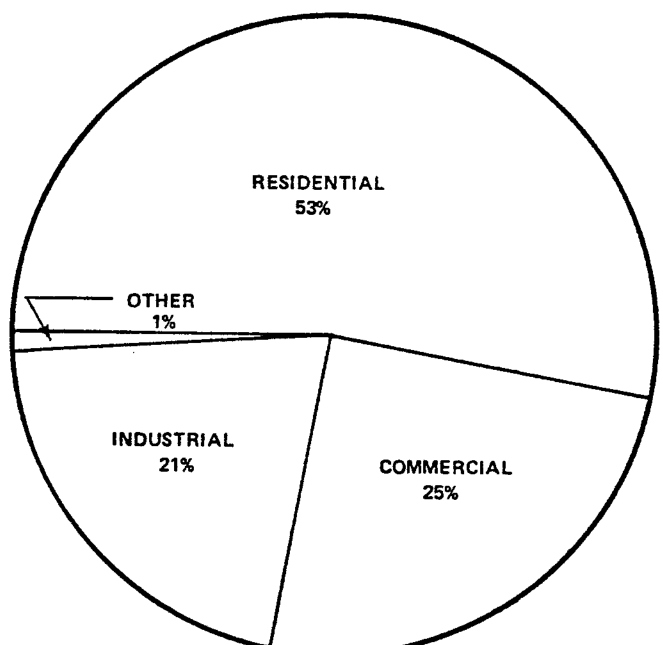
Figure 8 presents the distribution of the 1976 normalized energy consumption to each of the four consuming sectors: residential, commercial, industrial, and other.[11,12] These pie charts aid in establishing where the greatest impact of conservation measure may be felt.

Table 5 further subdivides the energy consumed into each sector into its two important components: the space conditioning component that is dependent on the weather parameters as discussed under Monthly Consumption and the base load component that consists of such diverse elements as process heat, water heating, cooking, lighting, and power. Note that the space cooling load amounts to only 15 percent of the total electric power consumption. This seemingly low value results from the fact that three-quarters of all the cooling degree days are concentrated in just three months: July, August and September. Although cooling amounts to about 40 percent of the electric power consumption in each of these three months, over the course of a year the base load in the noncooling months works to reduce the percentage of energy used for space



TOTAL 888 x 10^6 KWH

A. ELECTRICITY



TOTAL 7.60 x 10^{12} BTU

B. NATURAL GAS

FIGURE 8. DISTRIBUTION OF ENERGY BY CONSUMER (1976 NORMALIZED CONSUMPTION)

TABLE 5. DISTRIBUTION OF ENERGY BY END-USE PERCENTAGE OF ANNUAL CONSUMPTION

	Electricity			Natural Gas		
Consumer Category	Space Cooling	Base	Total	Space Heating	Base	Total
Residential	9	29	38	24	29	53
Commercial	5	40	45	9	16	25
Industrial	1	12	13	5	16	21
Other	0	4	4	0	1	1
TOTAL	15	85	100	38	62	100

cooling on an annual basis. Space heating, on the other hand, amounts to 38 percent of the annual consumption of natural gas and 65 percent of the natural gas consumption in each of the four heating months: December, January, February, and March.

Figure 9 presents a perspective on the total energy consumption in Riverside for stationary purposes (i.e., consumption exclusive of transportation). For every Btu of electrical energy that is consumed (1 kwhr = 3413 Btu), 2.5 Btu's of natural gas is consumed. Of the total energy consumed, 31.4 percent is consumed by space conditioning requirements, and 68.6 percent is consumed to satisfy the base load requirements.

Current Trends in Energy Consumption

As indicated in the preceding section, the basic sources of energy in Riverside are electricity and natural gas. However, in order to accommodate the needs of the subsequent tasks in this alternative energy study, it was necessary to take the preceding data concerning the sources of energy in Riverside and evaluate demands for the total energy requirements within the community. As such, two categories of energy demands were established:

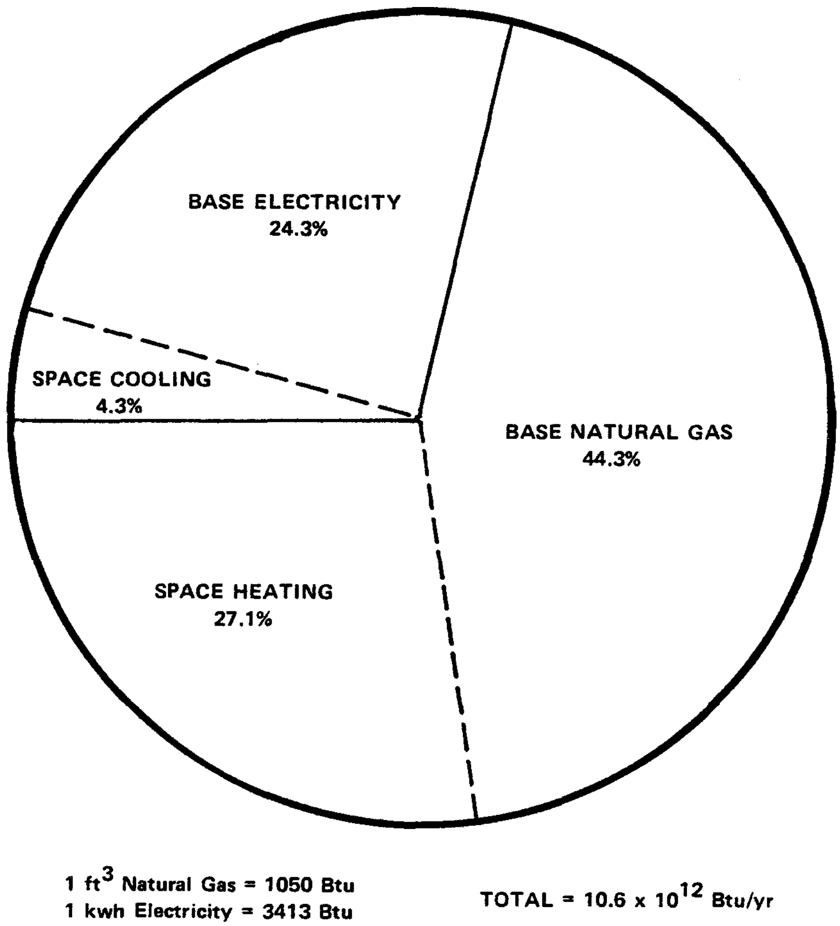


FIGURE 9. TOTAL STATIONARY ENERGY CONSUMPTION (NORMALIZED 1976)

(1) Thermal Demands, including

- Space heating
- Hot water
- Process heat
- Cooking heat

(2) Electrical Demands, including

- Space cooling
- Power
- Lighting

Note that the electricity consumed for heating requirements is included under thermal demands, while that for space cooling requirements is included as part of the electrical demands.

The current consumption patterns in Riverside closely correspond to this classification: natural gas for most thermal requirements; electricity for lighting and power requirements. The aim of this study, however, is not only the potential reduction of energy demands through conservation, but also the partial displacement of non-renewable sources of energy*such as natural gas, by other sources of energy. Thus, the establishment of thermal and electrical demand categories provided a rational approach to the evaluation of energy demand in Riverside, independent of limitations on the current supplies of energy. In this way, the projection of energy demands in the next section was established according to the expected growth patterns in Riverside. Subsequent tasks have then evaluated the effect of conservation measures on these projections, as well as the feasibility of displacing the conventional resources currently meeting these demands with alternative energy forms.

Energy Density Maps

It was mentioned earlier that census tracts were selected as the basic building blocks of the Riverside community. Maps of the City, subdivided into the component census tracts, were used to graphically portray the magnitude and distribution of thermal and electrical demands in Riverside. These maps were constructed by utilizing the demand information contained in the tables discussed in the Energy Matrix section below, along with measurements of the land area (square mile) of each census tract,[14] to provide energy-per-square-mile figures representative of the density of energy demands in a community (Btu/yr/sq mile).

* The word scarce is used in this report relative to natural gas and oil based fuels. This is not to imply that shortages of these fuels is imminent, but rather that their total supply capability is substantially less than other non-renewable energy sources such as coal and nuclear.

Figure 10 presents representative energy density maps for the energy consumed by all sectors in Riverside.

Figure 10a displays the total annual demands for thermal energy: space heating plus the base load. Such a map illustrates where the potential would be the greatest for applying district heating schemes to various sections of the community.

Figure 10b displays the space cooling requirements of the community. Such a map is useful when considering district cooling in conjunction with the district heating system discussed above.

Energy Matrix

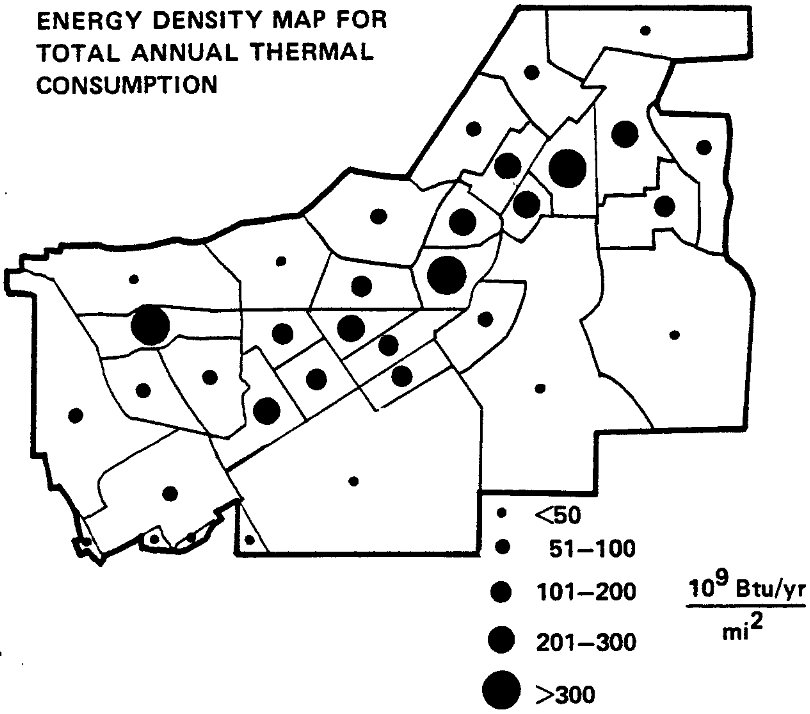
Figure 11 presents the concept of an energy matrix. Each box within the matrix contains the consumption patterns of each consumer category in a region. The general consumer categories are:

- Residential - those customers in dwelling units
- Commercial - those nonresidential customers who do not produce products as discussed under Industrial
- Industrial - those nonresidential customers who produce a salable manufactured or processed product.

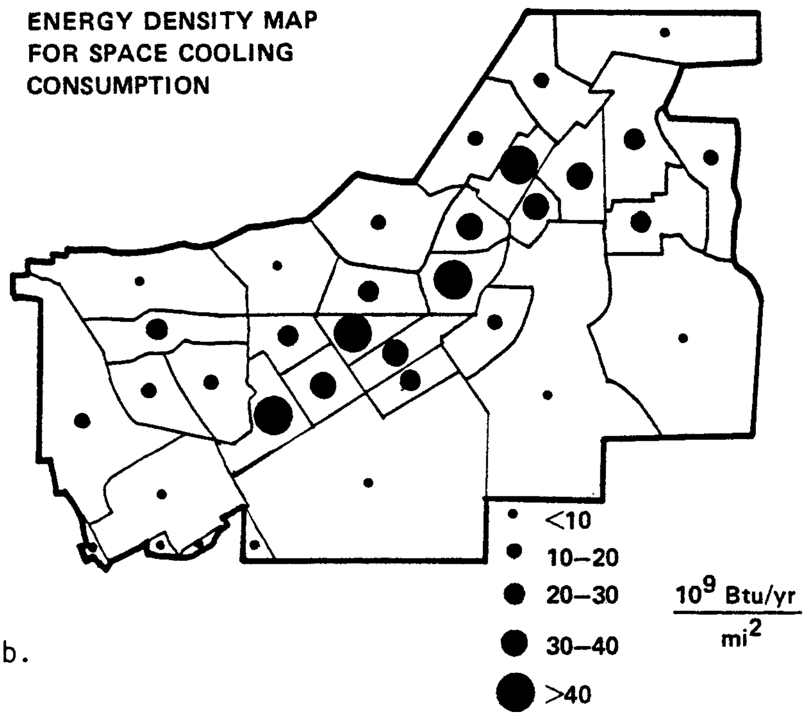
The regions selected for Riverside were the 31 census tracts within the City limits.

The energy consumption patterns are established by three generic categories:

- Peak Demand - The largest instantaneous diversified demand for energy which is expected to occur



a.



b.

FIGURE 10. ENERGY DENSITY MAPS

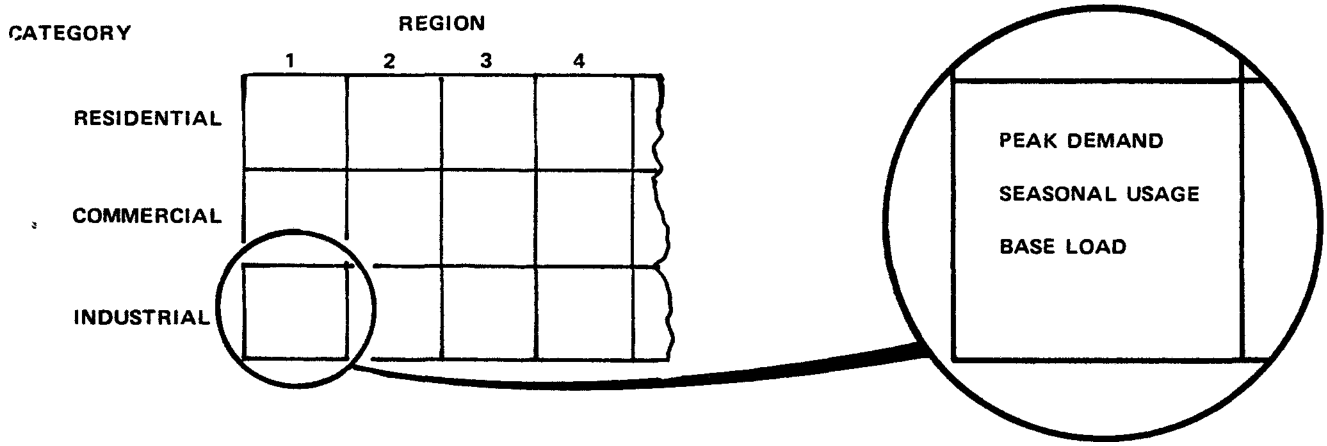


FIGURE 11. ENERGY MATRIX CONCEPT

- Seasonal Usage - That component of energy consumption identified with the average space conditioning requirements, either space heating or space cooling
- Base Load - That component of energy consumption that is not directly dependent on weather parameters. Water heating, process heat, lighting, and power fall into this category.

The energy matrix establishes the required design and performance characteristics for an alternative energy system: peak demands to size the system, and seasonal and base load consumption requirements placed on the system to establish the required performance of the system.

Figure 12 indicates the organization of the Riverside Energy Matrix. Each subcommunity is listed as a centered heading. The number of each census tract within the subcommunity is listed, along with the energy characterization of the three major consuming sectors. Both the thermal and electrical energy consumption characteristics are presented. The census tract characteristics are then summed for the subcommunity and listed under an abbreviation for the name of the subcommunity.

Figure 13 indicates the location of the subcommunities and census tracts within Riverside.

The energy consumption characteristics of each of the three major consumer categories are presented for each census tract within Riverside.[15,16,17] The census tract listings are grouped according to the subcommunities that they comprise. Both the thermal and electrical energy consumption characteristics are presented in the matrix which is given in Appendix B.

The thermal energy category represents the energy required by consumers within the city limits of Riverside to satisfy their thermal needs. It was derived from raw energy consumption data assuming the conversion efficiencies listed in Reference 35. It directly represents the thermal requirements that need to be satisfied. Thermal energy only indirectly represents the natural gas and electricity consumed for thermal needs, due to the assumed efficiencies of conversion.

Subcommunity Heading

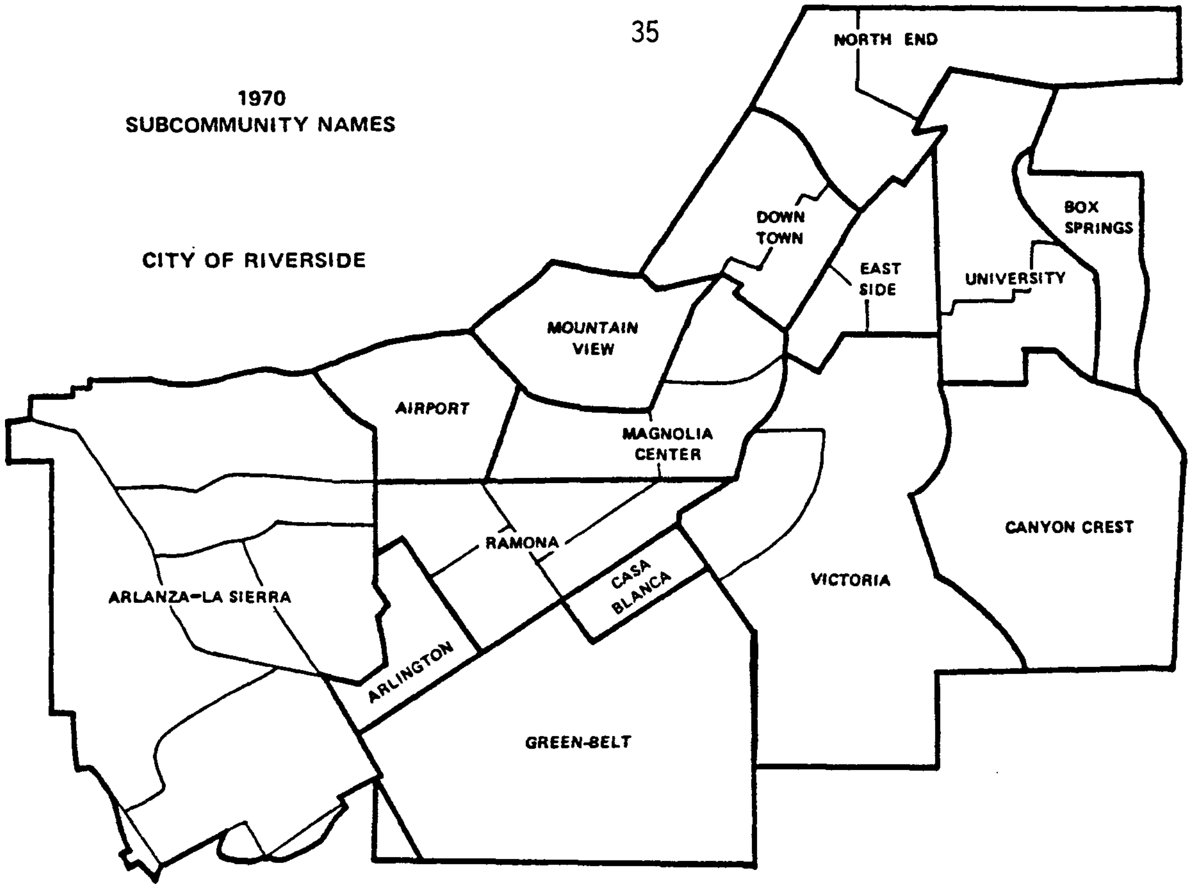
Census Tract No.	Consumer Classification	Thermal Characteristics: Peak Demand, 10^6 Btuh	Thermal Characteristics: Average Usage, 10^6 Btuh	Thermal Characteristics: Base Load, 10^6 Btuh	Electrical Characteristics: Peak Demand, MW	Electrical Characteristics: Average Usage, kW	Electrical Characteristics: Base Load, kW
			Ramona				
314.01	Residential	55.0	15.0	12.0	5.1	690	1,235
	Industrial	0.0	0.0	0.0	0.0	0	0
	Commercial	3.7	1.3	1.4	1.0	110	460
	TOTAL	58.7	16.3	13.4	6.1	800	1,695
314.02	Residential	48.0	13.0	9.9	4.4	610	1,055
	Industrial	0.0	0.0	0.0	0.0	0	0
	Commercial	19.0	6.5	7.6	4.9	570	2,390
	TOTAL	67.0	19.5	17.5	9.3	1,180	3,445
315.01	Residential	36.0	9.7	7.2	3.2	450	780
	Industrial	0.0	0.0	0.0	0.0	0	0
	Commercial	20.0	6.9	8.1	5.1	605	2,535
	TOTAL	56.0	16.6	15.3	8.3	1,055	3,315
315.02	Residential	47.0	13.0	9.1	3.8	590	670
	Industrial	0.0	0.0	0.0	0.0	0	0
	Commercial	4.8	1.7	1.9	1.2	145	610
	TOTAL	51.8	14.7	11.0	5.0	735	1,280
R.	Residential	186.0	50.7	38.2	16.5	2,340	3,740
	Industrial	0.0	0.0	0.0	0.0	0	0
	Commercial	47.5	16.4	19.0	12.2	1,430	5,995
	TOTAL	233.5	67.1	57.2	28.7	3,770	9,735
			Casa Blanca				
313	Residential	20.0	5.4	3.9	1.8	250	420
	Industrial	5.6	0.9	2.9	1.2	65	310
	Commercial	11.0	3.6	4.2	2.7	320	1,340
	TOTAL	36.6	9.9	11.0	5.7	635	2,070
C.B.	Residential	20.0	5.4	3.9	1.8	250	410
	Industrial	5.6	0.9	2.9	1.2	65	310
	Commercial	11.0	3.6	4.2	2.7	320	1,340
	TOTAL	36.6	9.9	11.0	5.7	635	2,070

Itemized Census Tracts Within Subcommunities

Totals for Ramona

Casa Blanca Has Only One Census Tract

FIGURE 12. ORGANIZATION OF THE RIVERSIDE ENERGY MATRIX



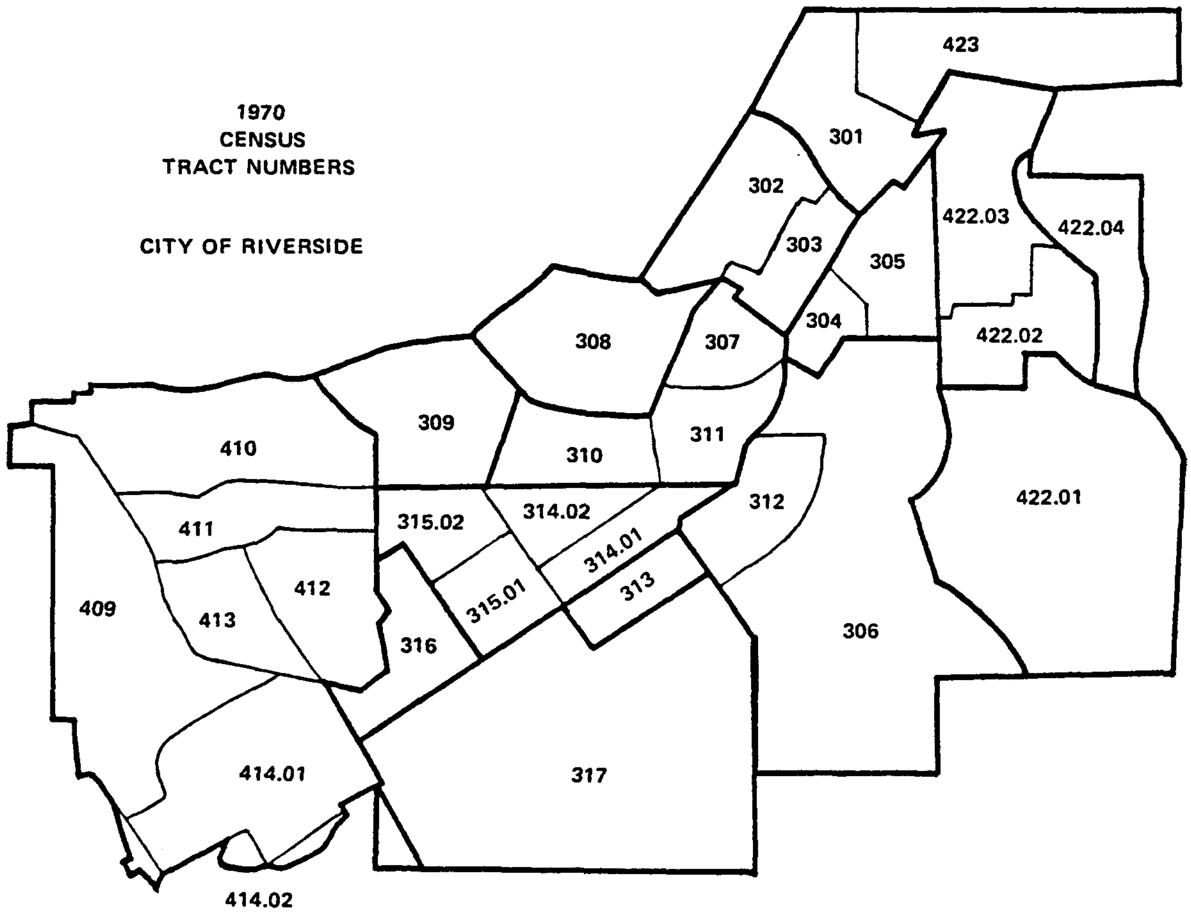


FIGURE 13. SUBCOMMUNITIES AND CENSUS TRACTS WITHIN RIVERSIDE

The electrical energy category represents the energy required by consumers within the city limits of Riverside to satisfy their electrical needs, exclusive of the electricity used to satisfy the thermal requirements which was included in the thermal category. It was derived directly from electrical energy consumption data. This category represents the electrical energy consumption characteristics as would be seen by an electrical generating station. The great preponderance of electric air conditioning equipment in the community was the rationale behind including space cooling under the electrical energy category.

Stationary Energy Consumers

Residential

Among the statistical data available on the number of residential units in Riverside, the years 1966 through 1974 are represented in information from the 1970 U.S. Census and from a Riverside Area Postal Vacancy Survey. This information is displayed in Table 6.

Of the figures shown in Table 6, those as of 4-1-70 are the most reliable and accurate because they reflect the official 1970 Census. These census data are also available in greater detail, reflecting a finer breakdown of residential building types (see Table 7).

Thus, the 1970 ratio of single-family to multifamily to mobile home units is approximately 78.8 percent : 20 percent : 1.2 percent, or 65-2/3 : 16-2/3 : 1. A more detailed examination of this ratio in a historical context reveals the picture shown in Table 8.

This trend shown in Table 8 indicates that during the 10 year period 1966 to 1975, the proportion of single-family homes has decreased in favor of a marked increase in the share of multifamily units, and a slight increase in mobile homes. Other data show evidence that in the multifamily category, the duplex category has experienced a drop in its share while the types of multifamily units housing more than five dwellings have increased their share of all multifamily dwellings. However, the available data are not sufficient to permit this to be substantiated by numbers.

TABLE 6. NUMBER OF RESIDENTIAL UNITS BY TYPE AND YEAR IN RIVERSIDE

	Number of Single-Family Homes	Number of Multifamily Units	Number of Mobile Homes	Total Units
1-1-66	34,987[b]	7,866[b]	350[c]	43,203[c]
1-1-67	35,187[b]	8,023[b]	400[c]	43,610[c]
1-1-68	35,462[b]	8,256[b]	450[c]	44,168[c]
1-1-69	35,812[b]	8,652[b]	500[c]	44,964[c]
4-1-70	36,213[a]	9,174[a]	541[a]	45,928[a]
1-1-71	36,421[d]	10,400[d]	718[c]	47,539[d]
1-1-72	36,791[d]	11,606[d]	782[c]	49,179[d]
1-1-73	37,255[d]	12,851[d]	1,005[c]	51,111[d]
1-1-74	37,886[d]	13,929[d]	1,176[c]	52,991[d]
1-1-75	38,105[d]	14,583[d]	1,212[c]	53,900[d]

Sources of Data:

(a) 1970 Census Data.
(b) Planning Department, City of Riverside - "Population and Housing".
(c) Battelle estimate based on available data sources (a), (b), and (d).
(d) Riverside Planning Department - "Riverside Area Postal and Vacancy Survey".

TABLE 7. DETAILED BREAKDOWN OF 1970 CENSUS DATA FOR THE NUMBER OF RESIDENTIAL UNITS IN RIVERSIDE ON 4-1-70

Number of Single-Family Homes	36,213	(78.8 percent)	
Number of Units Built as Duplexes	1,726	(3.75 percent)	(20 percent)
Number of Units Built in 3- or 4-Plexes	1,993	(4.34 percent)	
Number of Units in Buildings Housing 5-49 Units	4,724	(10.30 percent)	
Number of Units in Buildings Housing 50+ Units	731	(1.61 percent)	
Number of Mobile Homes	541	(1.20 percent)	
Total	45,928	(100.0 percent)	

TABLE 8. HISTORIC RATIO OF SINGLE-FAMILY DWELLINGS TO MULTIFAMILY DWELLINGS TO MOBILE HOME UNITS

Year	(Percent) Single-Family	Multifamily	Mobile Home
1966	81.0	18.2	0.8
1967	80.7	18.4	0.9
1968	80.3	18.7	1.0
1969	79.6	19.2	1.2
1970	78.8	20.0	1.2
1971	76.7	21.8	1.5
1972	74.8	23.6	1.6
1973	72.9	25.1	2.0
1974	71.5	26.3	2.2
1975	70.7	27.1	2.2

Estimate of Current Number Of Residential Units in Riverside. Using the historical data and indicated trends as a basis, the current number and mix of residential units in Riverside can be estimated with some reliability.

The current housing stock in Riverside (mid-1977) is estimated to be 59,800, distributed as follows:

Single-Family Homes	45,200	(75.6 percent)
Multifamily Units	12,400	(20.7 percent)
Mobile Homes	2,200	(3.7 percent)

The current distribution of multifamily residential building types may be estimated on the basis of the detailed 1970 Census information displayed previously in Table 7. By strict transfer of the ratios displayed in that Table to the 12,400 multifamily units estimated for mid-1977, the following breakdown results:

Duplexes	2,325	(18.75 percent)
Triplex, Quadriplex	2,691	(21.70 percent)
5-49	6,386	(51.50 percent)
50+	998	(8.05 percent)
Total	12,400	

However, the 1970 Census already noted a trend of a lessening in duplex construction and of an increase in multiple units, especially in the 50+ category. As a result, the mix of multifamily units was modified to reduce the proportion of duplexes and to increase the proportions of the 5-49 and 50+ categories:

Duplexes	1,922	(15.5 percent)
Triplex, Quadriplex	2,480	(20.0 percent)
5-49	6,572	(53.0 percent)
50+	1,426	(11.5 percent)
Total	12,400	

Based on the above discussion, the current number of residential units (as of mid-1977) in Riverside is estimated as follows:

Single-Family Homes			45,200	(75.6 percent)
Multifamily Units			12,400	(20.7 percent)
Duplexes	1,922	(15.5 percent)		
Triplex, Quadriplex	2,480	(20.0 percent)		
5-49	6,572	(53.0 percent)		
50+	1,426	(11.5 percent)		
Mobile Homes			2,200	(3.7 percent)
Total			59,800	(100.0 percent)

Commercial

Commercial building space was estimated using data on the energy consumed by this sector (see Appendix B) and space increase/energy use estimates from Title 24 Building Standards Testimony[18]. It was estimated that (1) average energy use for the commercial sector is 115 kwhr/sq ft/yr, (2) total commercial space in mid-1977 was 13.6 x 10^6 sq ft, and (3) the ratio of commercial to industrial space is 1.7:1.

Industrial

Almost all of Riverside's industry is located in 12 industrial parks and districts. The City has over 2300 acres zoned for light, medium, and heavy industry. About 50 percent is vacant and available in parcels ranging from 1/2 to 300 acres. Industrial properties in Riverside are excellent because they are (1) served by at least one railroad and, in some cases, two or three, (2) close to major freeways, and (3) on level, well-drained land with existing utilities and streets.

There are 96 manufacturing plants in the City of Riverside. Among the top 15 manufacturing employers in Riverside are those producing aerospace and aircraft products, electronic equipment, aluminum products, food processing equipment, food and food container products, and mobile homes and recreational vehicles. Riverside is considered to be a major center for mobile home manufacturers. Table 9 shows the top 15 manufacturing employers in Riverside.[19]

Companies with less than 100 employees represent 90 percent of the industry in the area. Most of these small companies (particularly the 80 percent with less than 50 employees) conduct service and/or supply activities and could be classified as commercial with regard to the type and amount of energy they use. It is common to look at companies with greater than 100 employees as (1) being large enough to use significant amounts of energy, and (2) having a special interest in energy conservation. About 10 percent (31 companies) fall into this category. Further analysis of these 31 companies resulted in the data shown in Table 10.[20]

TABLE 9. LARGEST MANUFACTURING EMPLOYERS, CITY OF RIVERSIDE, 1977[20]

Rank	Name of Firm	Approximate Employees	Products
1	Bourns, Inc.	1,325	Electric components
2	Fleetwood Homes, Inc.	1,325	Mobile homes
3	Alfred M. Lewis, Inc.	1,200	Food distributors
4	Rohr Industries	950	Aerospace and aircraft components
5	Riverside Daily Press	700	Newspaper and rotary press products
6	American Metal Climax-Amax	450	Aluminum sheet, foil, plate, rod, bar and fabricated products
7	Owens-Illinois - Lily-Tulip, Division	415	Paper and plastic cups, containers
8	Toro Company (Irrig. Div.)	400	Automatic irrigation systems
9	Hunter Engineering Co. Inc.	300	Aluminum rolling mills, stretch-levellers-line, print lines
10	Riverside Cement Co.	285	Cement products
11	Loma Linda Foods	250	Vegetable products, foods, cereals and gravies
12	Cal-Togs of California - BR and BR Sportswear	150	Ladies sportswear
13	E.T. Wall	150	Orange Packer/shipper
14	Broadmore Mobile Homes, Inc.	85	Mobile homes
15	FMC Corporation	75	Food processing equipment

TABLE 10. DISTRIBUTION OF INDUSTRIAL FIRMS IN THE RIVERSIDE, CALIFORNIA AREA ACCORDING TO NUMBER OF EMPLOYEES

Number of Employees	Number of Firms in Each Category
Greater than 1000	2
501 - 1000	2
251 - 500	4
101 - 250	24
51 - 100	26
11 - 50	100
Less than 10	138

Although these statistics are based on a broader area than the city limits of Riverside, they are illustrative of the types and sizes of industry located there. With reference to Table 11, the following observations are apparent:

- The largest number of firms in any one category concerns those building mobile homes. This clearly supports the claim that Riverside is a center for this industry. Several of the mobile home companies are part of Fleetwood Industries, which represents one of Riverside's largest industries, as shown in Table 9.
- About two-thirds of the largest companies are in the category of energy intensive industries, i.e., cement, aluminum products, food processing, plastics, transportation equipment, fabricated metals, etc. The Riverside Cement Company is not within the city limits and was not considered in this program, although it was visited because it is a large energy user and the only company in the area using coal as a fuel.
- All of the companies are performing a variety of manufacturing operations having relatively low energy use characteristics, as discussed in later sections.

TABLE 11. TYPES OF INDUSTRIAL FIRMS IN THE RIVERSIDE, CALIFORNIA AREA WITH MORE THAN 100 EMPLOYEES

Number of Employees	Number of Companies	Type of Business
Greater than 1000	1	Electronics
	1	Aerospace
501 to 1000	1	Newspaper and Rotary Press Products
	1	Cement Products
251 to 500	1	Aluminum Products
	1	Machinery
	1	Manufacturer -- Irrigation Systems
	1	Construction -- Asphalt Mixes
101 to 250	2	Plastics
	2	Transportation Equipment and Machinery
	2	Prefabricated Buildings
	1	Clothing
	4	Fruit Packing
	1	Electronics
	1	Cement Mixing-Pipe
	1	Food Equipment
	7	Mobile Homes -- Recreational Vehicles
	1	Food Processing
	1	Metal Fabrication
	1	Printing

Characterization of Industrial Energy Use in Riverside. Characterization of industrial energy use was derived from several data sources. These were:

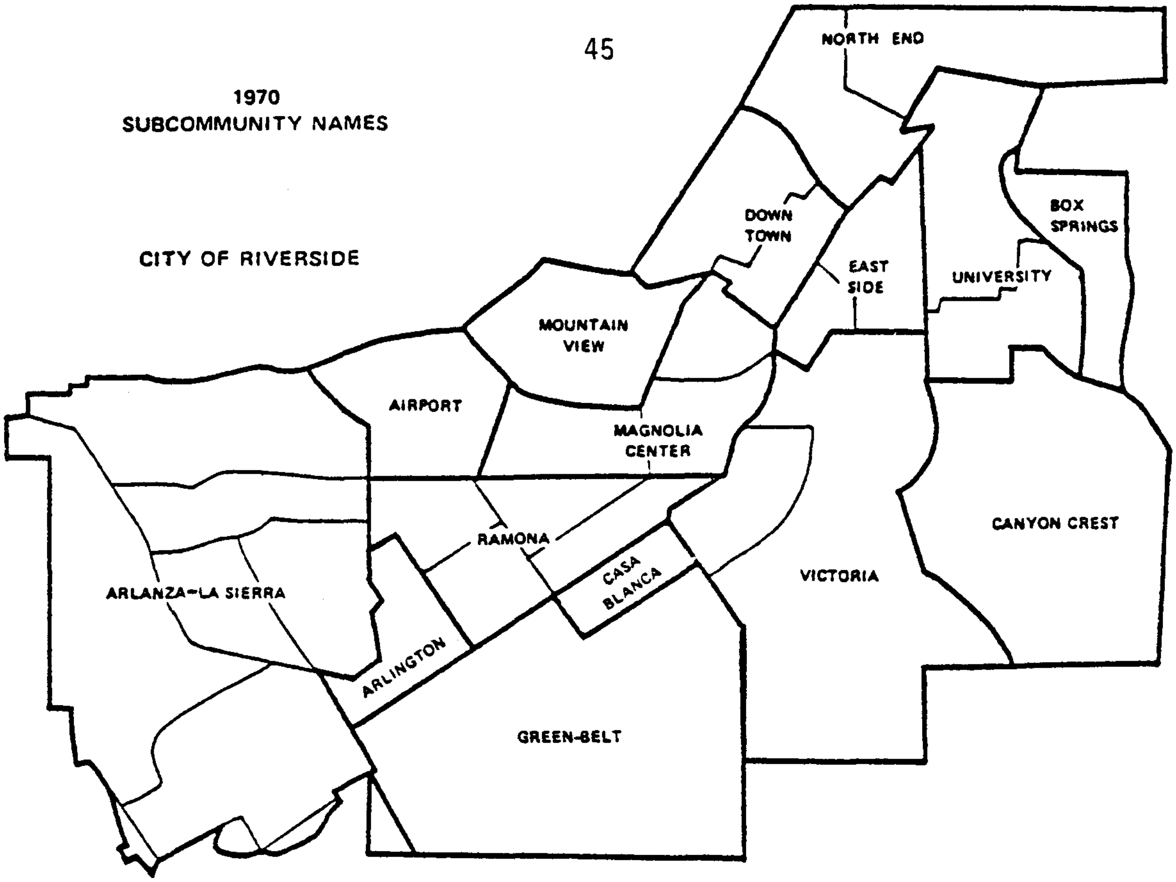
(1) Direct contacts with industry
(2) Characterization of Riverside Energy Consumption Patterns, as described in Appendix B
(3) Energy Conservation Opportunities in Buildings, as described in Appendix C1
(4) Utility data, giving electricity and natural gas use of large energy consumers, usually identified only by census tract but also by individual companies in some cases where permission was obtained

(5) U.S. Environmental Protection Agency Point Source Listings for Riverside Companies. These Point Source Listings were not useful for determining total energy use, nor for characterizing energy use within the companies. In some cases boiler types and sizes could be obtained, as well as the types of some processing equipment which may contribute to environmental emissions.

Distribution of electricity and natural gas use by type of consumer was already shown in Figure 8. Electricity use is for lighting, power (electric motors, etc.) and space cooling. Natural gas use is for thermal requirements such as space heating, hot water heating, process heat, and cooking. The industrial use of electricity (13 percent total) and natural gas (21 percent total) are relatively small portions of Riverside's total energy consumption, which supports the idea that Riverside is basically a residential community. It is obvious then that the major energy savings from energy conservation will come from the residential and commercial sectors.

Data from the Riverside Energy Matrix (Table B-7, Appendix B) were used to produce a Riverside Industrial Energy Use Matrix (shown in Appendix C2, Table C2-5) showing subcommunity names and census tracts. It is apparent which communities are residential/commercial (no industrial energy use) and which are industrial. Those census tracts that show major industrial energy use are those in which industrial parks are located. A more graphic picture of locations where industrial energy is used in Riverside is shown in Figure 14.

The 12 census tracts having industrial operations were ranked in decreasing order of the total energy used, as shown in Table 12. This clearly shows where the concentration of industrial energy use is located. Seventy-eight percent of the total industrial energy use is in three census tracts--411/Arlanza-La Sierra, 422.03/University,and 305/East Side. The other 9 census tracts have nominal energy use ranging from 5 percent to less than 1 percent of total industrial energy use, and reflect the operations of many small firms each using relatively little energy.



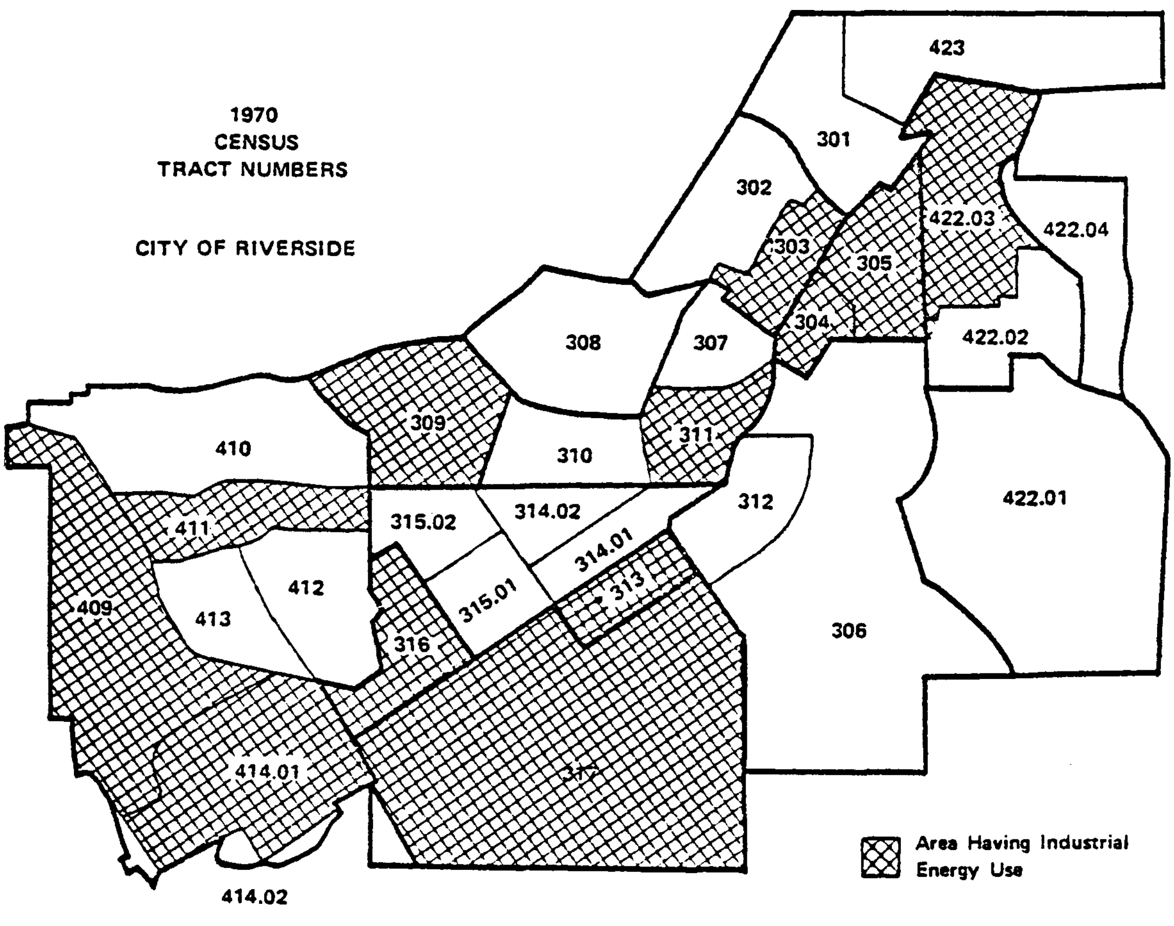


FIGURE 14. SUBCOMMUNITIES AND CENSUS TRACTS WITHIN RIVERSIDE

TABLE 12. RANKING IN DECREASING ORDER OF TOTAL ENERGY USED IN CENSUS TRACTS HAVING INDUSTRIAL OPERATIONS

Ranking	Census Tract	Community	Annual Thermal Energy Use, Btu x 10^9	Annual Electrical Energy Use, Kwhr x 10^6	Total Btu's Used[(a)], Btu x 10^9	Total Btu's Used for Industrial, percent
1	411	Arlanza-La Sierra	481.6	17.9	664.2	33
2	422.03	University	452.4	49.6	505.9	25
3	305	East Side	212.2	18.9	404.9	20
4	304	East Side	96.6	10.4	106.1	5
5	317	Green Belt	30.7	5.6	87.8	4
6	409	Arlanza-La Sierra	45.2	1.4	59.5	3
7	313	Casa Blanca	28.0	3.0	58.6	2.8
8	303	Downtown	16.3	3.9	56.8	2.6
9	414.01	Arlanza-La Sierra	31.8	2.1	53.2	2.4
10	309	Airport	33.6	1.8	18.4	1
11	311	Magnolia Center	7.6	0.79	15.6	0.7
12	316	Arlington	7.6	0.35	11.2	0.5
		Totals	1443.5	115.7	2042.2	100

(a) Kilowatt Hour conversions to Btu made at 10,200 Btu/Kwhr to reflect the amount of oil burned at the electrical generating plant.

Using data obtained directly from the industrial companies surveyed, further analysis was made which resulted in the following findings:

- Rohr, Inc. dominates energy use in Census Tract 411, using about 50 percent of the total energy amount in this area. Rohr is also the largest natural gas user in Riverside[21] and the third largest electricity consumer supplied by the Riverside Public Utilities Department.[19]
- The University of California at Riverside (UCR) dominates energy use in Census Tract 422.03, using about 50 percent of the total energy amount in this area. UCR is the largest electricity consumer in Riverside being supplied by the Riverside Public Utilities Department[19] and among the largest natural gas consumers.[22] UCR is classed as a commercial customer by the Riverside Public Utilities Department; however, for the purposes of this study it has been considered as an industrial user.
- Other significant energy consumers in Census Tract 422.03 are the Lily Division of Owens-Illinois and AMAX. Adding these to UCR accounts for about 75 percent of the total energy used in this area.
- About one-fourth of the total energy used in Census Tract 305 is a combination of Alfred M. Lewis, Inc. and Toro, Irrigation Division.
- FMC Corporation uses about 15 percent of the total energy amount in Census Tract 304.
- The Press-Enterprise Company uses about 50 percent of the total energy amount in Census Tract 303. Their energy use is practically all electrical.

This analysis was designed, within the limitations of the data available, (1) to point out the total amount of energy used by Riverside industry, (2) to indicate the areas of the City which have industrial operations, (3) to rank the industrial areas by amount of total industrial energy used, and (4) to identify large energy users that dominate or have a major impact on industrial energy use in some of the larger energy consumption areas. This information was then used to evaluate energy conservation opportunities for industry and sizing and location of alternative energy systems.

Current Energy Conservation Activities

Buildings

Local Building Conservation Efforts. On the basis of conversations held with local officials in City Hall, County Government and the Chamber of Commerce, it appears that building energy conservation efforts in Riverside need to be expanded and intensified significantly. The City as well as the County Government are presently engaged in active programs to conserve the energy used by the buildings they own. However, this action is generally limited to energy conservation measures that are operational in nature (e.g. lowering the heating temperature, raising the cooling temperature, switching off lights) and does not include major retrofit programs. Moreover, the amount of interior space owned by the City and the County is only a fraction of Riverside's entire building inventory. As a result, these efforts have served more as an example of prudent action to the City's residents, than as major contributors to energy savings.

Although the City of Riverside owns its electrical distribution system, it has no generating capacity and relies on the Southern California Edison Company for almost all of its power. In an effort to reduce its peak demand, the City's Public Utilities Department has instituted a consulting service for business and industry, providing advice on proper load management. This consulting service is patterned after the one offered by Southern California Edison Company. Currently the City has four full-time staff members involved in energy conservation. This emphasis, initiated in 1973 among customers with loads above 200 KW, has resulted in significant reductions in electrical usage based upon field audits by the City. Some of these results are as follows:

Riverside General Hospital - Energy conservation control system in planning.

Park View Hospital - Lighting changed to energy saving fluorescent lamps. Energy system planned and 20 percent reduction guaranteed by the supplier.

J.C. Penney Company - Delamping program, 250,000 KWH annual savings.

K-Mart - 30 percent reduction in lighting.

University of California - Riverside - Computer demand control installed. In-house energy conservation committees.

Another small load management program has been conducted by the City, involving an appeal to swimming pool owners to install an extra set of on/off trippers on existing time switches.

The Riverside Chamber of Commerce, in response to the 1973 Arab oil embargo, embarked on a program to "de-escalate" outdoor sign illumination. This action was, however, short-lived, and is no longer being promoted by the Chamber of Commerce. More recently, the Chamber's Conservation Committee has inaugurated a series of seminars and workshops aimed at local business and industry to promote conservation of all types of energy use.

A major local building-related energy conservation program is the one at March Air Force Base at the southern edge of Riverside. This program emphasizes operational conservation actions, maintenance to sustain equipment efficiency, and a certain amount of retrofit. Although March Air Force Base is not within the corporate boundaries of Riverside, its (over) 5,000 military and over 1,200 civilians are a major influence on the local economy.

Regional Building Conservation Efforts. Locally-based and advocated energy conservation programs are often difficult to implement effectively because of fear that large fractions of the business and industrial communities may move to areas with less stringent requirements. Energy conservation programs that are advocated and implemented on a regional basis create a more uniform operational climate, and may therefore not only be more effective but may permit additional local programs to flourish under their umbrella of uniformity. For example, a regional energy conservation plan that includes certain tax penalties for noncompliance may induce some communities in that region to step up their conservation efforts by offering incentives for compliance. This example shows that it may be advantageous to consider punitive/disincentive programs at the regional level, and to permit individual communities to offer rewards for compliance at their own discretion. If this were done, communities could compete in an environment that offers uniform punishment for noncompliance, yet permits each community to allocate its own, unique rewards for compliance.

The mechanisms to permit such a symbiosis between local and regional programs do not yet exist in the Riverside region. Few, if any, regional entities of government in Southern California carry the legal powers necessary to enforce disincentive programs, and local communities generally do not have the flexible capital or other resources needed to offer significant incentives. As a result, the prominent regional energy conservation programs for buildings are conducted by regional public utility companies - not by regional government units - and they are incentive programs - not punitive ones.

Programs by Southern California Gas Company. Both the Southern California Gas Company and the Southern California Edison Company are now operating under a mandate from their Public Utilities Commission which is causing them to advocate energy conservation on the part of their customers. This mandate essentially states that future rate increase justifications must be accompanied by evidence that the public utilities have actively conducted programs to urge all of their customers to conserve energy.[23]

The resultant energy conservation programs conducted by the Southern California Gas Company have had the most impact on the City of Riverside. This is because Southern California Gas sells to individual customers in Riverside, whereas Southern California Edison sells its electrical power to the City's Public Utilities Department in bulk, who then resells it to individual customers.

A number of innovative incentive programs are offered by the Southern California Gas Company to its individual customers. A selected number of these programs is described below.

(1) A 10 percent discount on labor and materials for residential customers who contract to have attic insulation installed. This discount is offered periodically in different market areas of the Gas Company.

(2) Consulting services by the Gas Company for industrial customers. Free advice is given on ways and means to conserve gas use, and free adjustments to equipment are made.

(3) The Gas Company offers water flow restrictors and water heater insulation kits for sale at significant discounts to its customers. This discount is offered periodically in different market areas of the Gas Company.

(4) An "800" Area Code Hot Line with a 24-hour answering service for personal advice on energy conservation matters.

(5) A consumer information program with Gas Company representatives who talk to different groups and organizations, or who man "conservation centers" in high-traffic areas of the city.

(6) A "Concern Award" to encourage builders and architects to include energy-saving features exceeding those required by building standards for new homes and apartments. New housing developments qualifying for this award are featured as energy-conserving projects presented in Gas Company-paid advertising in local newspapers, and Gas Company representatives are present in model homes to help market the energy-saving features.

(7) Similar "Concern Award" programs exist for manufactured housing and for commercial and industrial customers.

(8) A Real Estate Retrofit Pilot Program to encourage the retrofitting of older homes. The Program, now discontinued, encouraged home sellers to have their homes weatherized before the sale, thus making the homes more valuable and more saleworthy.

At the present time, the Gas Company continues actively to promote such programs among its customers in Riverside.

Programs by Southern California Edison Company. Southern California Edison Company has an equally intensive and multifaceted energy conservation program; however, its impact on the City of Riverside has not been as direct as that of the Gas Company's. This difference stems from the fact that, while the Gas Company sells to individual customers in Riverside, Southern California Edison sells its power in bulk to Riverside's Public Utilities

Department, who in turn, resells it to individual customers in Riverside via its own power grid. This resale relationship causes the impact of Southern California Edison's conservation programs to be once removed from the customers.

Southern California Edison can therefore only promote energy conservation through the mass media in Riverside rather than mandate or directly influence such action. Because the City of Riverside would have to bear the cost of implementing any direct programs, few have been initiated. In addition, since revenues to the City partly consist of net earnings from the resale of Southern California Edison's power, successful efforts to obtain significant conservation would reduce Riverside's revenues. In fact, to maintain the level of income to the City's General Revenue Fund, the City would need to increase utility rates in direct proportion to the amounts conserved, thus nullifying any financial advantages of energy conservation. Coupling this condition with the fact that Riverside--not Southern California Edison--must pay for implementing its own conservation programs, it is clearly evident that Riverside may have little incentive to initiate bold and comprehensive programs to conserve electricity unless there is political and public support aimed at stabilizing energy supply and minimizing the eventual impact of higher energy costs.

Because of the applicability of many of the Southern California Edison programs to Riverside, a listing of titles is presented below.

- Home Insulation
- Electric Water Heating Conservation Program
- Advertising
- Consumer Education Program
- Energy Conservation Kit for New Customers
- Sure Actions for Valuable Energy Savings (SAVES)
- Expanded Information/Publicity
- Commercial/Industrial/Public Authority Energy Audit
- Commercial Customer Contact Program
- Solar Water Heating Demonstration/Publicity Program
- Load Management
- Waste Heat/Cogeneration.

Notes on conversations held with Southern California Edison's Conservation Planners[24] show that the "Commercial/Industrial Public Authority Energy Audit" for those using over 200 KW is considered to be the most successful program, yielding an annual reduction of nearly 400 million KWHR, and exceeding program goals by over 40 percent. This is the same program that the Riverside Public Utilities Department has already made available to large industrial users in Riverside.

Statewide Building Conservation Programs. California's programs to develop building codes which encourage the construction of energy-efficient buildings are among the most far-reaching in the United States. These programs, effective July, 1978, are described in three documents available from the State of California's Energy Resources Conservation and Development Commission.[25]

The standards for energy conservation in new residential buildings indicate design guidelines for minimum levels of insulation, for the placement of vapor barriers, for passive solar energy design for glazing areas and minimum thermal resistance of glazing, and for minimum levels of infiltration. With respect to climate control systems and equipment, the standards provide a methodology for the selection of systems by life cycle cost calculation, and they set parameters for equipment efficiencies, equipment sizing (50 percent over design heat load now, 30 percent after January 1, 1979) and for the workmanship quality of hot and cold air circulation ducts. Water heating systems are the third and final area for which parameters are given. Electric resistance water heating is generally discouraged, unless life cycle cost calculations show it to be equivalent to that of natural gas or solar installations. Swimming pool heating systems are similarly governed, and insulation is required for steam or condensate piping and for hot water piping in unheated areas. Enforcement of this residential code is delegated to local code enforcement authorities. In areas without such enforcement capabilities, the State will review plans and specifications. The State is the final authority on the interpretation of this code, and a dispute procedure is established to resolve differences in code interpretation between applicants and building departments. Locally promulgated codes are acceptable substitutes only if they are more stringent than the State's code. Procedures to hear claims for exemption from this code are provided to accommodate situations where substantial design occurred prior to code inception, but where construction is expected after inception.

The residential building code requirements for energy conservation are, in their major provisions, generally equal to those set forth in ASHRAE Standard 90-75, entitled "Energy Conservation in New Building Design", and released by ASHRAE's Committee on Standards in August 1975. However, two additional provisions in the California Code go beyond ASHRAE 90-75 and may thus make it more effective than the 7.5 percent energy savings for single-family homes or the 45.4 percent savings for low-rise multifamily apartments (as forecast for ASHRAE 90-75 in the western United States).[26] These two provisions are:

(1) The requirement of life cycle cost analysis for the selection of climate control systems, and

(2) The encouraged use of passive solar design by permitting certain glazing areas of southern orientation to be exempt from the maximum glazing rules.

However, no data have been discovered to date to substantiate any claims that the California residential energy conservation standard is more effective than ASHRAE 90-75. As a result, it should be conservatively assumed that the impact of the California standard will be similar to that of ASHRAE 90-75, especially since actual results will depend heavily on the vigor and accuracy of code enforcement and code interpretation.

The provisions of the <u>nonresidential energy conservation building code</u> differ significantly from those of the residential code just described. Essentially, compliance with the nonresidential code may be obtained in one of three ways.

(1) New designs may be developed to fall within certain energy budgets (Btu/sq ft/yr) for given building types to satisfy code requirements;

(2) New designs that obtain 40 percent of their thermal energy needs or 20 percent of all energy needs from nondepletable sources will be in compliance with the code;

(3) New designs may be developed in compliance with the code if they fall within the restrictions placed on the design of the building envelope, the HVAC systems and equipment, the service water heating systems, and electrical and the lighting system. Enforcement procedures, procedures for the hearing of exemption claims, and other administrative regulations are similar to those described for the residential code.

It is difficult to determine whether the California nonresidential code is equal in its potential impact to that estimated for ASHRAE 90-75. A cursory and preliminary comparison between the California code and ASHRAE 90-75 reveals some aspects to be equal, others to be more stringent in one code, and yet others to be more stringent in the other. In an attempt to estimate the possible savings from the California code, it has been projected that average annual savings for the City of Riverside will be 1.95×10^6 KWHR from 1977 to 1996.(18) Based on Riverside's annual consumption of roughly 1×10^9 KWHR at the present time, this savings would appear to be negligible, e.g. on the order of 0.2 percent of electrical use per year through 1995.

This illustration demonstrates that building codes governing the energy efficiency of new buildings have a negligible effect on overall energy savings. This is the case because:

(1) New buildings generally make up only a small part of most communities' building inventories

(2) New buildings always <u>add</u> to a community's total energy use, unless they are totally reliant on renewable fuels, or unless an existing building of equal size is demolished and thus removed from the inventory. Only after many years will

> the cumulative savings from new construction become substantial, and only after the existing building inventory has either been retrofitted or removed will maximum savings be realized.

In spite of this situation, the record indicates a significant leveling in the rate of electrical consumption beginning in 1973 (Figure 6). This leveling can be attributed largely to a combination of: 1) the closing of the local Alcan plant; 2) leveling of new construction; 3) higher energy costs; 4) voluntary actions on the part of large industry; and 5) appeals through the mass media as well as the programs promoted by the City, the Chamber of Commerce and the Southern California Gas Company.

It is clear that although the City of Riverside has implemented some operations-related conservation measures in municipal buildings and along with the Southern California Gas Company and the Chamber of Commerce has implemented a conservation program to encourage reductions in electrical usage among large industrial and commercial consumers, there is a need for expanding and intensifying energy conservation efforts in Riverside.

In addition, it is evident that the future application of the new statewide building codes will increase the energy efficiency of newly constructed buildings but will not have an immediate, significant effect. Two significant shortcomings exist in this present thrust to conserve energy in the Riverside buildings. These are:

- The absence of a concerted, locally controlled and systematic program to conserve the energy used by the buildings in Riverside
- The lack of programs directed at upgrading the energy efficiency of the largest and most significant component of Riverside's building inventory--the existing building stock. Although building codes governing new construction do result in "savings" by reducing the <u>increase</u> in energy demand, codes requiring retrofit will result in actual <u>reductions</u> of present energy use.

Community Design

One area of potential energy conservation that has not received much attention is community design. Communities evolve over time and because energy conservation has not had a high priority until recently, the layout and operation of the community exhibit in most cases, a lack of energy efficiency.

The scope of this activity involved an investigation of current energy conservation activities in Riverside relative to community design which included: community development patterns, current relationship of land uses and buildings, the application of "passive" design within the community, and the street lighting system.

Community Development Patterns

Based on discussions held in Riverside with City officials, local architects, planners, and builders, very little effort has been implemented relative to energy conservation in community design. Development patterns have not changed to any degree although a community development master plan has been devised for the Arlington Heights area. Here, proposed residential land-use densities are based primarily on the requirement for provision of urban services and the preservation of the natural features of Arlington Heights. Thus, the flatlands area includes the highest residential densities relative to lower cost of urban services, whereas the citrus tree area displays the lowest residential density, reflecting the desire to preserve citrus groves and provide a community layout representative of a series of villages.

Relationship of Land Use and Buildings. Recent research further substantiates that energy usage is lower in more densely populated areas than in less densely populated areas. By consolidating a number of dwelling units in one building envelope, the wall area exposed to the outside air is also reduced. Heat transmitted through interior walls can be used in adjoining building units and not lost to the exterior. As a result, temperature differences across adjoining walls will be so small that heat transmission will be kept to a minimum, thus stabilizing interior temperatures and decreasing energy demand.

For even further energy conservation, residential buildings may be arranged in clusters and incorporate multi-use space and individual living units, as well as common spaces to accommodate activities for which the living units may not be adequate.

Unfortunately, very little has been done in Riverside to increase density because of the strong desire to control residential growth and retain a low-density development strategy. Currently, the majority of housing (75 percent) consists of single-family detached units, while only 21 percent is low-rise apartment development. At present, there are only two high-rise apartment buildings in Riverside. While others are planned for the central business district, there is no desire to rush into higher density housing.

Passive Solar Design. Passive solar design concepts rely on natural energy, contain few mechanical parts or complex hardware, require little or no energy themselves, and tend to be low in cost when compared to active solar systems. The primary requirements for properly designed passive systems involve a provision for thermal storage within the structure, and the control of heat flow into and out of the building.

Currently, there are no buildings of this type in existence or under construction in Riverside. Neither has the City developed any planning policy in which passive solar design is considered.

Street Lighting. Between 1969 and 1973, the City of Riverside upgraded their street lighting system. At present, the City has approximately 21,946[27] street lights. Of this amount, 18,196 are mercury vapor lamps, 3,550 are incandescent, and 200 are high-pressure sodium vapor. Another 650 new mercury vapor lights are expected to be added during the time period July, 1978 to June, 1979.

Currently, the City has turned off street lighting on one side of the street in the downtown area in an effort to save energy. In other commercial areas every other street light has been turned off. Of the 21,946 street lights in Riverside, 1,317 have been turned off--1,289 mercury vapor and 28 incandescent. Since all of Riverside's street lighting system only constitutes 2-1/2 percent of the City's total electric consumption, energy conservation efforts have had a minimal impact, except as an example to the public of the importance of energy conservation.

The Public Utilities Department has investigated and tested photo controls that turn off lights at midnight or some preset number of hours after they have turned on. However, performance was not considered to be satisfactory. The Department is currently investigating a new type of cell that will reduce total energy consumption by the street lighting system by about 20 percent. This new solid state unit is expected to achieve significant savings by turning on 15 to 30 minutes later and off 90 to 105 minutes earlier than existing units.

Following the Arab oil embargo in 1973, the Riverside Chamber of Commerce initiated a program to encourage the reduced use of illuminated outdoor signs. However, this program did not continue for long.

Industry

Industrial Conservation Programs. As might be expected, the large energy users are usually larger companies that have effective energy management programs. Such companies characteristically have the technical staff and incentives to develop an energy management plan and follow through with its implementation and operation.

An example is Rohr Industries, Incorporated, one of the largest energy users in Riverside. An energy conservation program was initiated in mid-1975, and during 1976, electrical energy use decreased 25 percent and natural gas use 36 percent.[38] Water use management is also a part of the program. The overall program is comprehensive and includes:

- Appointment of a responsible energy coordinator
- A committee of plant management and employees
- A plan for energy management with targets for reduced energy use with regular reporting
- Prominent displays of energy use/cost data on production/processing equipment
- An education program for all employees aimed at energy use in the plant and in the employee's home, transportation, etc.

Another example is the University of California at Riverside. Energy conservation guidelines were established early in 1974 in response to the energy crisis of 1973-74, and from that time through 1975-76, use of electrical energy has decreased about 14 percent and use of natural gas has decreased about 32 percent. Water management is also a part of the program. Early savings resulted from modifications to operating procedures, while present and future savings will accrue from improvements to existing systems and new energy saving facilities. In the latter category, a computerized energy management system is being installed and will be operational in late 1978. New guidelines for conservation and management of energy and water were issued in June 1977, with the goal of saving 30 percent per annum (related to 1972-73) of electricity, natural gas and liquid fuels (oil is available as a standby fuel).

It was apparent from the data received from other large industrial energy users that several were monitoring energy use closely. Thus, while the larger industrial energy users are good candidates for achieving the greatest energy savings, they may already be realizing an appreciable part of possible energy savings through energy conservation. They are, of course, highly interested in the stability of costs which might be achieved by the implementation of alternative energy systems.

Some of the "smaller" companies are divisions of larger companies, such as the Lily Division of Owens-Illinois and Safeway Stores. These companies participate in the energy conservation programs of their parent corporations, and have generally achieved significant energy savings even though they do not have in-house energy conservation organizations. In general, the energy conservation responsibility in these divisions and other small companies lies with the plant manager. Cost benefits are considered closely when looking at energy conservation options.

Some of the typical energy conservation measures implemented by smaller companies in Riverside include:

- Sizing electrical motors and staging operation to lower electrical demand
- Installing air or plastic-strip curtains at freezer-cooler doors
- Turning off as many incandescent lights as possible, and removing 30 to 50 percent of the fluorescent lamps
- Setting thermostats at 68 to 70° in winter and 74 to 75° in summer
- Changing air conditioning systems to enable increased use of outside air, employing less humidity control
- Correcting power factors 95 to 98 percent
- Cleaning and adjusting boilers (usually with Gas Company help)
- Using the telephone more, thus cutting down mileage on company vehicles
- Better planning of deliveries and other vehicle trips.

Indigenous Alternative Energy Resources

Indigenous alternative energy resources were identified and information collected relative to the volume potentially available to Riverside.

Coal

California itself has no significant indigenous coal supplies and no working mines.[29] The most likely source of coal for use in Southern California is Utah. Two industries near Riverside - Riverside Cement in Rubidoux and Kaiser Steel in Fontana - currently use coal from Utah as an energy source.

The Utah coal resource is substantial with mapped reserves of 39.3 billion tons of which 24.3 billion tons are measured, indicated, or inferred.[30] This estimate is a minimum and is expected to increase by 20 to 30 percent as further exploration takes place. In 1980 coal production is expected to reach 17 million tons. Utah ranks behind only Wyoming and Montana in rate of increased coal production in the U.S.

In general, Utah coal is higher in heating value and moderately low in sulfur compared to other western coals. The two most important fields are the Kaiparowitz Plateau and the Wasatch Plateau.

The 1977 price of Utah coal delivered in Riverside is estimated at $1.40/10^6 Btu. This cost in constant 1977 dollars is expected to increase at a rate of approximately 3.2 percent per year through 1990 and 1.7 percent per year from 1990 through the year 2000.

The major options for utilization of coal in Riverside are to convert it to electricity in Utah or burn or gasify it along with other solid fuels in an integrated utility system in Riverside. These options are discussed in more detail in Appendix D1.

Solar

An emerging solar energy industry exists in Riverside and in nearby communities. At least one solar collector factory is located in Riverside which produces a collector similar to the collector found in this study to be optimum for Riverside. Several building contractors and heating and cooling contractors install solar equipment. Several large home builders in and around Riverside offer solar homes for sale. Given the favorable economic position of solar energy in this area, the solar energy industry should grow significantly in the next few years.

Solar Heating. Solar energy applications which supply hot water (including pool heating) and space heating are technically well developed and appear to be economically viable compared to electric heat in Riverside. Solar systems are about equivalent to gas heating on a 20-year life cycle cost basis. The influence of various tax incentives, including the California State Income Tax Credit, are important in making solar cost effective with other fuels.

Solar Cooling. Solar space cooling does not appear to be economically competitive with electric-driven compression cooling. A recent study[31] of the system installed on the Santa Clara Community Recreation Center concluded that solar-driven absorption cooling is not now economically viable, and probably would not become viable in the near term, even considering the improvements expected for absorption cooling units. Furthermore, since the space cooling load is relatively small, and can perhaps be reduced through passive design techniques (better insulated structures, nighttime cool down with internal storage), it would be inappropriate to promote solar absorption cooling in Riverside.

Solar Industrial Process Heat, Solar Thermal Power. Solar industrial process heat and solar thermal power also do not appear to be attractive economic alternatives in the near term because of the relatively low cost of gas to commercial and industrial users. The sophisticated concentrating, tracking collector systems needed to deliver the high temperatures required have not been developed to the same level of reliability as flat plate collectors. These systems are at least as expensive as flat plate systems and, therefore, cannot compete with low cost gas. The effective cost of gas to commercial and industrial users is much less than that to residential customers because it is a tax deductible business expense.

Geothermal

Survey of Geothermal Resources. A literature survey of the geothermal resources near Riverside identified eight resources within 200 miles that could be utilized to generate electricity. These eight resources contain an estimated electrical potential of 2749 MWe centuries (Table 13), which is enough to supply Riverside's electrical demands for over 2000 years. Over 20 hot springs within 50 miles of Riverside (Figure 15) were also found which might be suitable for nonelectrical applications. However, of these resources, only Arrowhead Hot Springs has significant known potential; too little is known about the others.

TABLE 13. ELECTRICAL POTENTIAL OF GEOTHERMAL RESOURCES WITHIN 200 MILES OF RIVERSIDE, CALIFORNIA[a]

Name	Subsurface Temperature, C	Electrical Potential, MWe Centuries
Coso	220	1360
Salton Sea	340	836
Heber	190	292
East Mesa	180	146
Brawley	200	100
Arrowhead	150	5
Border	160	5
Sespe	155	5
TOTAL		2749

(a) From USGS Circular 726

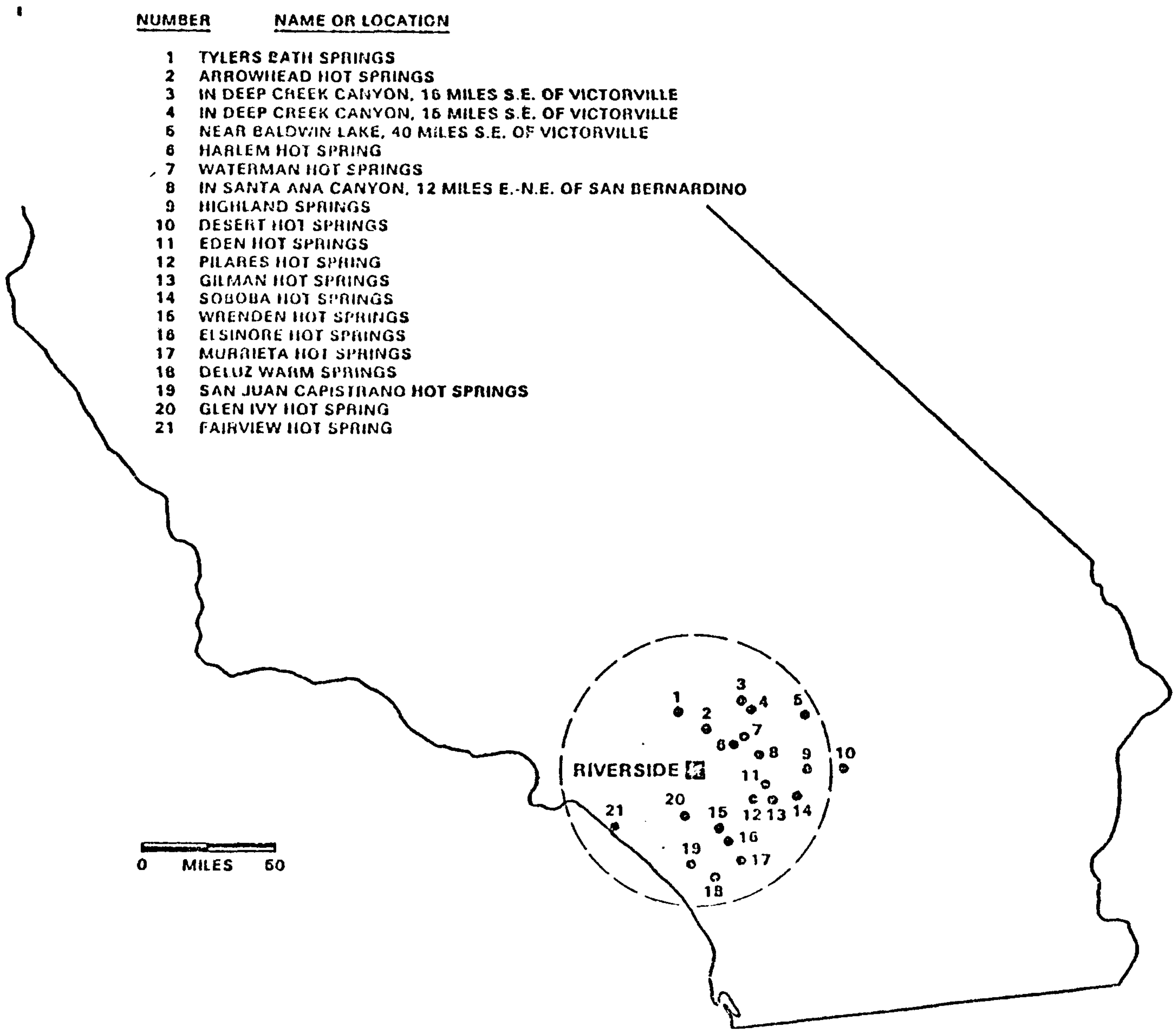


FIGURE 15. THERMAL SPRINGS WITHIN 50 MILES OF RIVERSIDE, CALIFORNIA

Resources up to 200 miles away were considered for potential electrical applications, although this is an arbitrary limit. Figure 16 shows the locations of all geothermal resources within 200 miles of Riverside with reservoir temperatures of 150 C or higher. These resources, which are described below, are considered promising for electrical generation. They include Coso Hot Springs in Inyo County, Sespe Hot Springs in Ventura County, Arrowhead Hot Springs in San Bernardino County, and Brawley, Border, East Mesa, Heber and the Salton Sea KGRAs (Known Geothermal Resource Areas) in Imperial County. The characteristics of these eight resources are summarized in Table 14. In addition to these identified resources, the shaded areas on Figure 16 are "areas classified as being prospectively valuable for geothermal steam and associated geothermal resources."[32] These areas are shown on a new map prepared by the National Geophysical and Solar-Terrestrial Data Center in cooperation with the ERDA Division of Geothermal Energy and the USGS.

If the 200 mile limit is relaxed, many additional geothermal resources could be considered. For instance, it might be possible to obtain electric power from The Geysers, the large commercial geothermal resource 450 miles north of Riverside. Regional tie-lines for bulk power transfer already exist between Northern and Southern California.

For potential nonelectrical applications we included resources located up to 50 miles away. Geothermal energy is competitive for space and process heating out to distances of 50 miles from the wellhead when employed on a large scale to serve concentrated markets.[33] The resources considered for nonelectrical uses include Arrowhead Hot Springs, Desert Hot Springs, and numerous thermal springs in the vicinity.

<u>Potential Resources for Electricity Generation</u>. Coso Hot Springs is located in the Mojave Desert in east-central California, about 150 miles north of Riverside. About 80 percent of the 51,760-acre KGRA lies within the U.S. Naval Weapons Center at China Lake, which is closed to the general public.[34] The Navy has announced plans to build a materials test facility and a 20-MWe power plant to utilize the geothermal energy.[35] The Coso Hot Springs KGRA is estimated to contain an electrical potential of 1360 MWe centuries.[36]

TABLE 14. GEOTHERMAL RESOURCES WITHIN 200 MILES OF RIVERSIDE, CALIFORNIA[a]

Name	Location: Latitude °N	Location: Longitude °W	Location: Miles From Riverside	Subsurface Temperature, °C	Reservoir Assumptions: Depth, km	Reservoir Assumptions: Heat Content, 10^{18} Calories	Total Dissolved Solids, PPM
Coso	36° 03'	117° 47'	150	220	1.0	41	5,800
Salton Sea	33° 12'	115° 36'	115	340	1.0	21	120,000-250,000
Heber	32° 43'	115° 31.7'	130	190	1.0	11	14,000
East Mesa	32° 47'	115° 15'	145	180	1.0	5.5	2,400-25,000
Brawley	33° 01'	115° 31'	120	200	1.5	3	54,000
Arrowhead	34° 08.6'	117° 15.2'	15	150	1.5	0.2	*
Border	32° 44'	115° 07.6'	155	160	2.4	0.2	*
Sespe	34° 35.7'	118° 59.9'	105	155	1.5	0.2	*
TOTAL						82.1	

(a) From USGS Circular 726.

* No data available.

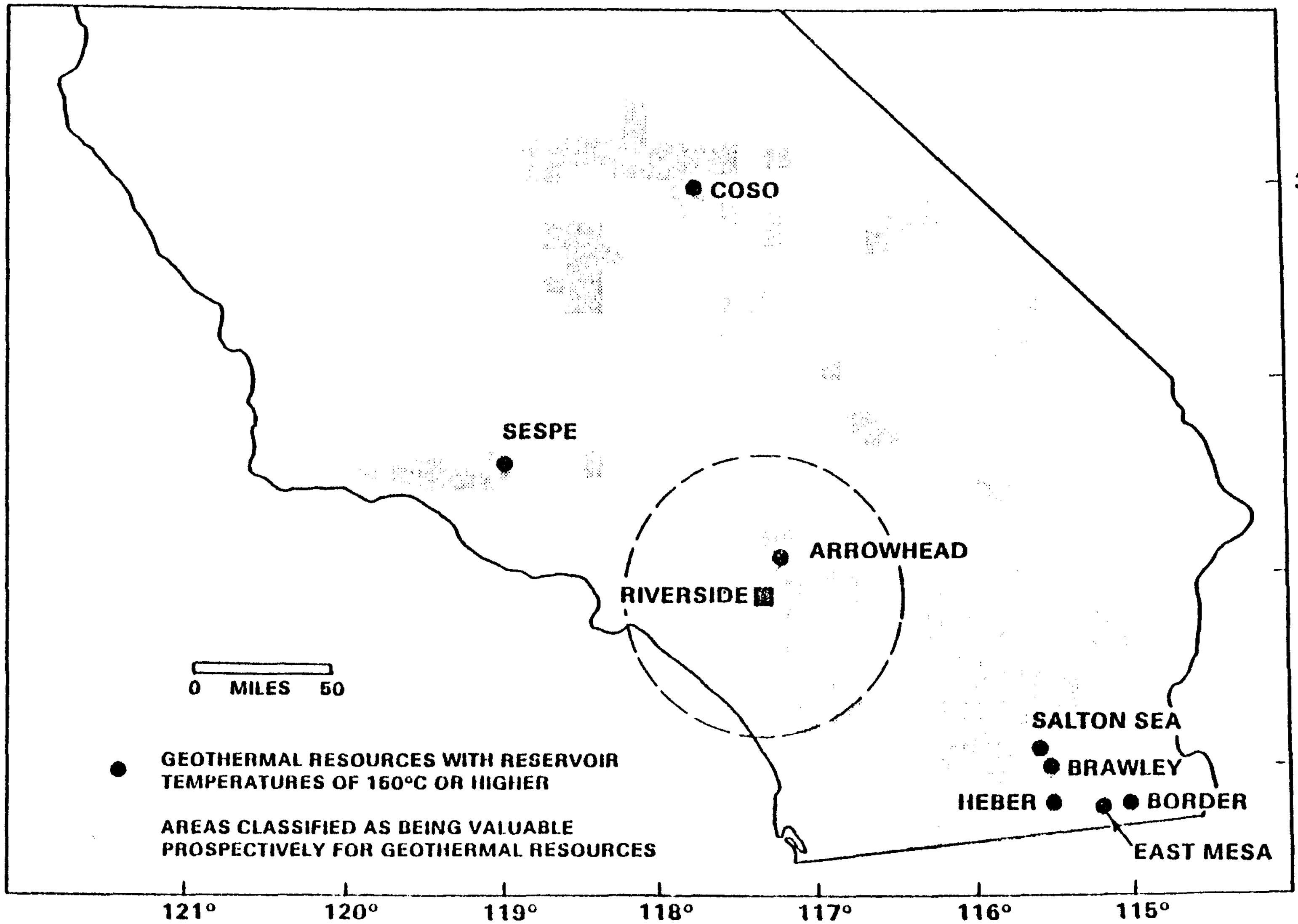


FIGURE 16. GEOTHERMAL RESOURCES WITHIN 200 MILES OF RIVERSIDE, CALIFORNIA

The USGS estimated this heat content for systems with minimal surface evidence by assuming a subsurface area of 1.5 km^2, a depth of 1.5 km, and a specific heat of 0.6 cal/cm^3 - C. Under these assumptions, the estimated electrical potential is 5 MWe centuries for each of the three geothermal resources. As further geological, geochemical, and geophysical data become available, these resources may prove to hold a much greater potential.

Potential Resources for Nonelectrical Applications. The geothermal resources with reservoir temperatures below 105 C are not suitable for economic electric power generation, but some of them have potential for space and process heating. According to USGS Circular 726,[36] there is only one geothermal resource above 90 C within 50 miles of Riverside. This resource, Arrowhead Hot Springs, is shown inside the 50-mile radius circle surrounding Riverside in Figure 16. However, a previous USGS paper[37] shows about 20 lower-temperature thermal springs in the area; this paper lists only the surface temperature of the water. In order to assess the potential of these springs, more data are required on the subsurface temperature and the heat content of the reservoir. Figure 15 shows the locations of these springs.

The geothermal resource nearest to Riverside is Arrowhead Hot Springs, about 15 miles north. The estimated temperature of this resource is 150 C, which makes it potentially useful for either electrical or nonelectrical applications. As mentioned previously, the USGS assumed a heat content of 0.2 x 10^{18} calories for Arrowhead Hot Springs. This amount of heat is equivalent to about 100 years of natural gas consumption in Riverside.

Waste-to-Energy

As the U.S. population becomes more densely congregated in major urban centers, greater emphasis has been placed on finding alternatives to past inexpensive landfill techniques of municipal refuse disposal. Refuse, which contains a number of hydrocarbon compounds, is potentially usable as an energy source. Refuse compositions vary substantially throughout the U.S., but on the average, refuse has about 6200 Btu/lb heating value on a dry basis and about 5000 Btu/lb on a wet basis with a moisture content of 20 percent.[38]

A recent study of landfill alternatives for the Riverside Community examined the quantities of refuse available.[39] Table 15 summarizes the daily quantities available at the preferred new Belltown landfill site in West Riverside. The Belltown site is located just northwest of the existing West Riverside landfill which is nearing completion.

TABLE 15. REFUSE QUANTITIES AVAILABLE IN RIVERSIDE AREA

	Daily Quantity, tons/day	Annual Quantity, tons (5-day weeks)
Riverside	290	75400
West Riverside	170	44200
Highgrove	90	23400
Badlands	5	1300
TOTAL	555	144,300

As can be seen from Table 15, the quantity of refuse available for energy recovery is about 555 tons/day or 144,300 tons/year assuming 5 days per week collection practice. Assuming 5,000 Btu/lb (10×10^6 Btu/ton), this amounts to 1.44×10^{12} Btu per year which is approximately 21 percent of Riverside's annual natural gas consumption (see Appendix B).

Two generic types of processes for energy recovery from refuse can be defined: (1) those based on combustion using water-tube wall incinerators and (2) those based on conversion of refuse to a gaseous or liquid fuel through gasification or pyrolysis.

A third process, which is really a special case of (2) above, involves tapping existing landfill and extracting methane gas which is produced by natural decomposition. It is estimated that 600,000 cubic feet of gas per day or 288×10^6 Btu per day could be produced from the existing Riverside landfill.

Biomass

Biomass, not including municipal refuse, consists of a wide variety of organic materials generally associated with the food industry, although timber harvesting waste and nonfood-related plants that may be grown specifically for energy recovery may also be included. The technology for converting biomass to energy is largely the same as that discussed earlier in this section for municipal refuse, i.e., incineration to raise steam, and gasification or pyrolysis to produce gases and liquids. Certain technologies have special attractiveness for certain types of biomass which, although applicable too, are not especially attractive for refuse. Examples are animal manures that are well adapted to producing methane through anaerobic digestion and certain crop wastes that are especially attractive for producing alcohols through fermentation.

The types of biomass and their availability are very geographically dependent. The cost of collection and transport per unit of energy content precludes shipment over long distances. In Riverside County, the types of biomass of any significance can be grouped into three categories, agricultural residue, dairy and feedlot manures, and timber harvesting waste. The amounts of these biomass types available, estimated energy recovery potential and energy cost are shown in Table 16.

Wind

Possibilities of Wind Energy in Riverside. Figure 17 shows wind speed duration data for March Air Force Base near Riverside.[41] These data are considered representative of wind conditions in Riverside.[41, 42] By combining the wind speed duration data of Figure 17 with the performance curves for the DOE and WTG machines* in Figure 18, the power duration curves shown in Figure 19 result. The actual amount of energy recoverable by each of the two machines over the course of a year is represented by the areas under each of the respective curves in Figure 18. The DOE MOD 0 machine, rated at 100 kw, produces about 37,600 kwhr per year under Riverside wind conditions, while the WG MP 1-200, rated at 200 kw, produces 15,600 kwhr per year. Note that even though the WTG machine is rated at twice the capacity of the DOE unit, it produces just less than half the power over the course of a year.

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* See Appendix D-6 for details.

TABLE 16. BIOMASS ENERGY AVAILABILITIES FOR RIVERSIDE

Type	Quantity, tons/year (40)		Energy Content		Cost, $\$/10^6$ Btu
	Low[a]	High[b]	Low	High	
Agricultural					
Industry	866	9,942	5.6	65.6[c]	4.50[f]
Field	6,264	188,030	40.7	122.2[c]	9.70[g]
Dairy & Feedlot Manures	124,792	361,104	312.0	902.8[d]	2.00[h]
Timber Harvesting Waste	2,514		26.4[c]		4.50[i]

(a) Sufficient quantity for 200 ton/day capacity at each source.
(b) All sources.
(c) When incinerated at 0.65 efficiency at 5000 Btu/lb.
(d) Methane from anaerobic digestion at 2.5×10^6 Btu/ton (38).
(e) When incinerated at 0.65 efficiency at 8000 Btu/lb.
(f) Delivered cost of $3.00/ton (40) plus cost of incineration at $\$4.00/10^6$ Btu.
(g) Delivered cost of $23.00/ton (40) plus cost of incineration at $\$4.00/10^6$ Btu.
(h) Methane delivered to pipeline (40).
(i) Delivered cost $5.00/ton plus cost of incineration at $\$4.00/10^6$ Btu.

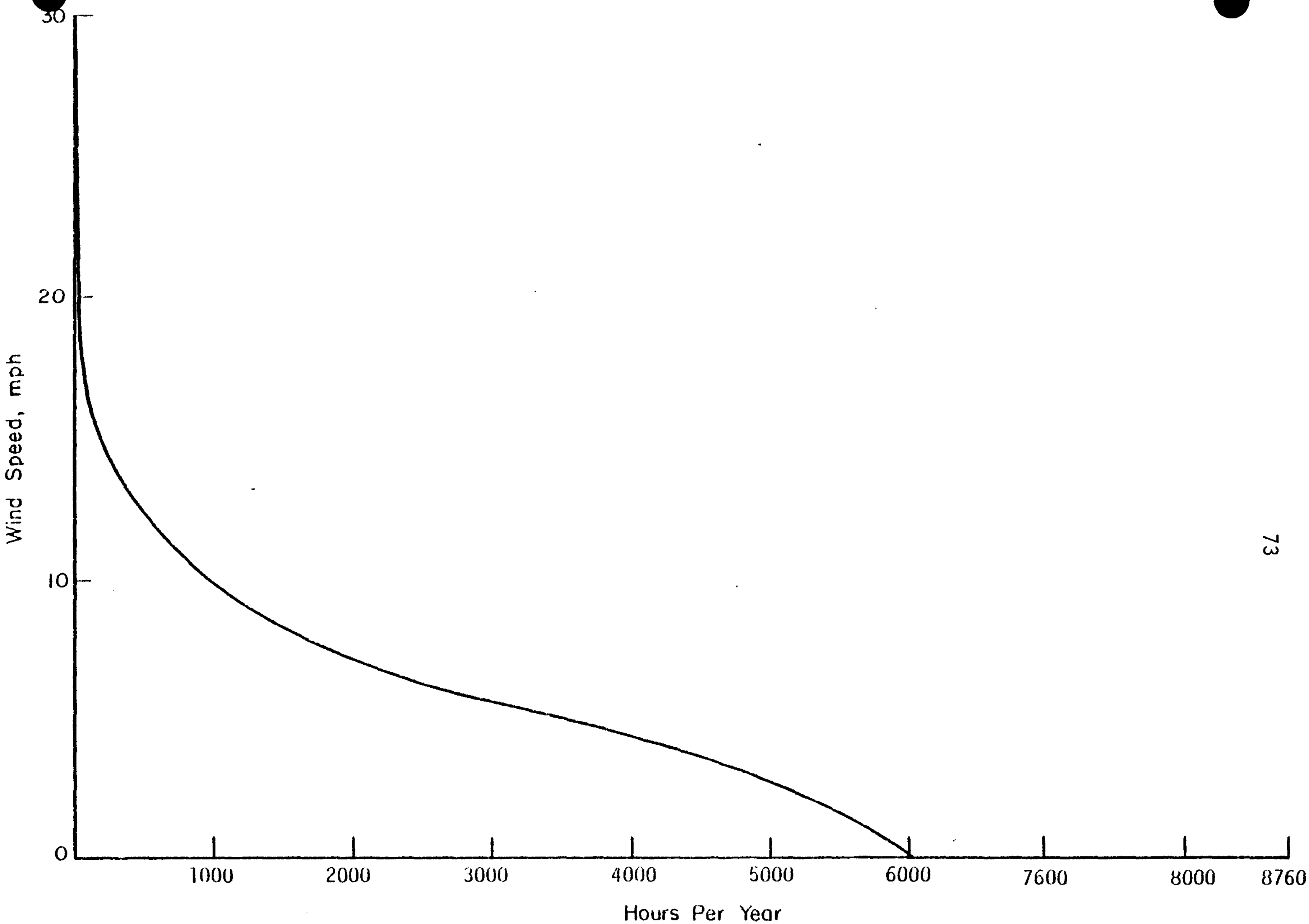

FIGURE 17. WIND SPEED DURATION FOR RIVERSIDE (40)
Hours per year wind speed is above stated velocity.

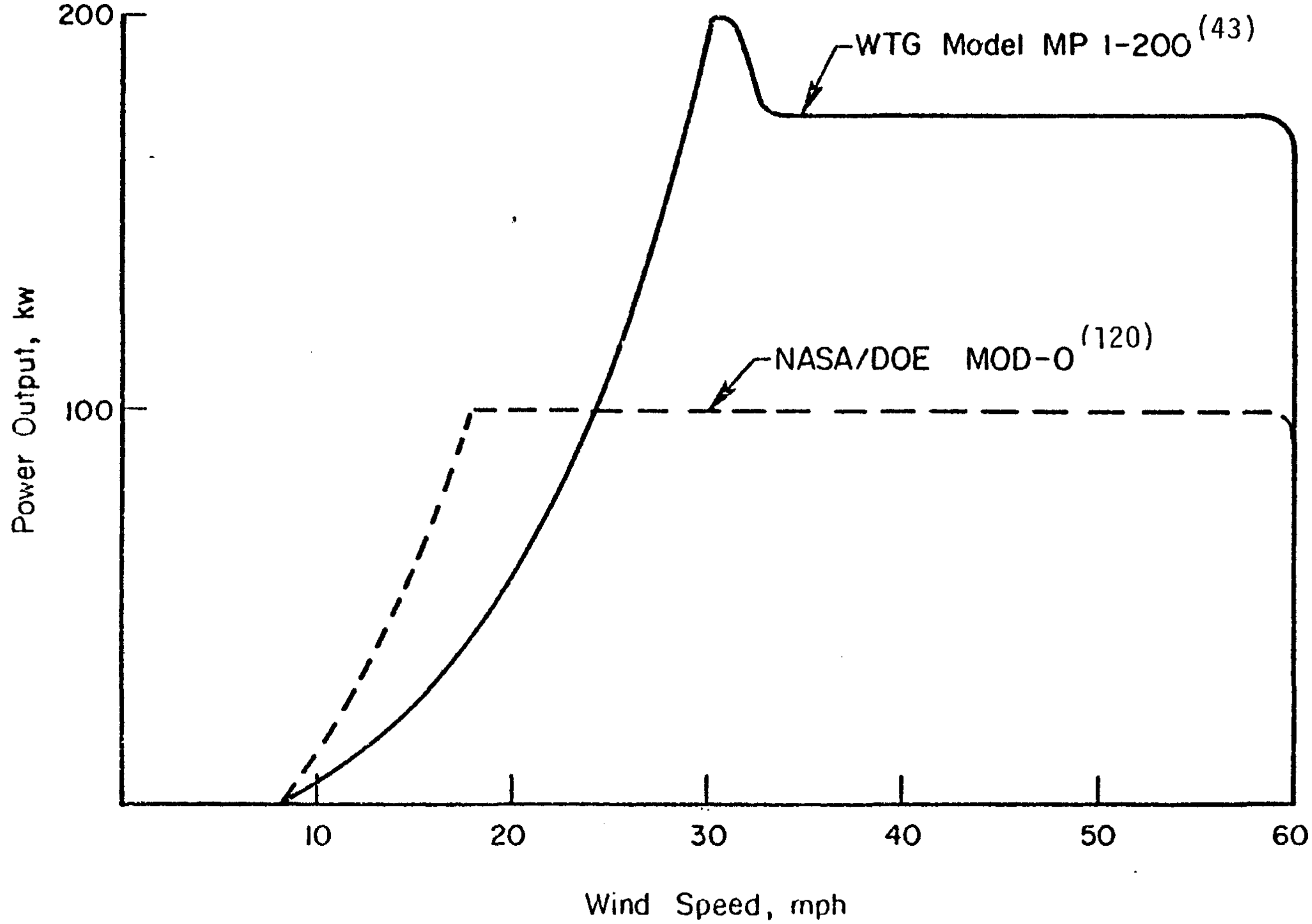

FIGURE 18. POWER OUTPUT VS WIND SPEED FOR REPRESENTATIVE WIND GENERATORS

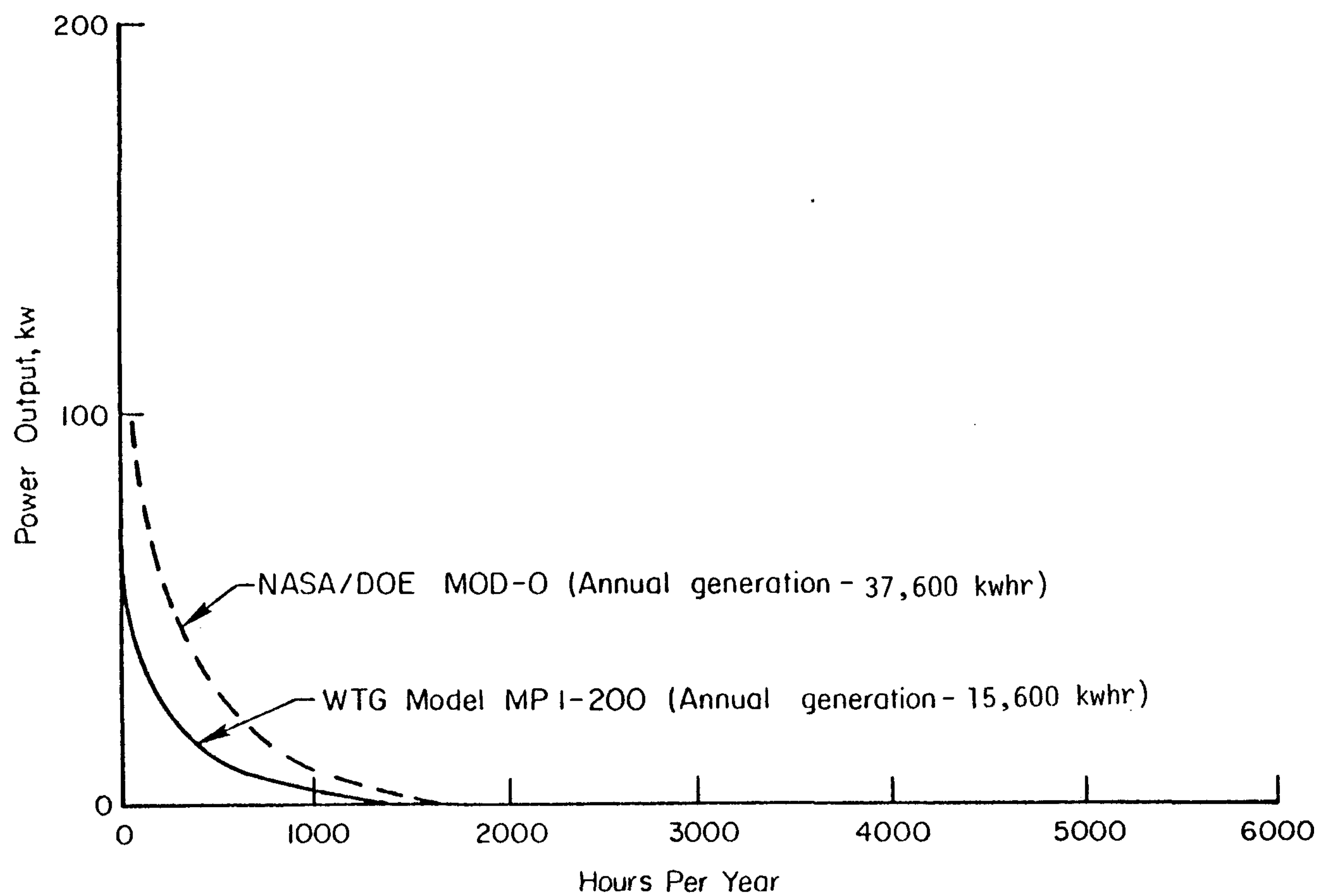

FIGURE 19. POWER DURATION FOR REPRESENTATIVE WIND TURBINES IN RIVERSIDE

Transportation

Transportation Modes

Characterization of Riverside Vehicle Population.[44] As of 1977 there were 89,166 automobiles and 16,165 trucks registered in the City of Riverside. Based on national averages, approximately 6,500 of the automobiles and approximately 5,200 of the trucks were fleet vehicles. (The corresponding numbers for large fleets, i.e., greater than 24 vehicles, are 2,700 and 500.) The City fleet is composed of approximately 770 vehicles (excluding police and fire) and meters some 3.8 million miles per year. The County fleet of approximately 650 vehicles logs somewhat more than 17,000 miles per vehicle per year. Most of these miles are driven outside the city limits, however. The U.S. Government maintains a fleet of 418 vehicles in Riverside (excluding Post Office and Forest Service vehicles); each of these vehicles is driven an average of approximately 14,000 miles per year, of which approximately 2,800 are logged within the city limits. The Riverside Bus System maintains 24 diesel buses which average approximately 4,000 miles per month. No information was available on school buses, but, based on national statistics, Riverside should have approximately 200 public school buses, each logging approximately 7,000 miles per year. In addition, there should be approximately another 100 school buses associated with private facilities. The University of California, Riverside, maintains a fleet of approximately 250 vehicles. No information was obtained on Post Office or police vehicles. Despite the unavailability of some information, all major fleets are assumed to have been identified. Based on national statistics, there should be approximately 800 more fleet vehicles in large fleets in Riverside than were identified. Major industry in Riverside was questioned but no other large fleets were identified. The "missing" fleets are assumed to have been: (1) fire, police, and postal vehicles, and (2) a result of the character of Riverside, i.e., as a bedroom and soft-industry community (as opposed to a heavy manufacturing community). Information obtained on large fleets in Riverside is summarized in Table 17.

TABLE 17. VEHICLE FLEETS IN RIVERSIDE

Type	Number of Vehicles	Approximate Average Mileage (annual)	Total Annual Mileage, million
City	770	5,000	3.85
County	650	17,000[a]	11.05
Federal	418	14,000[a]	5.85
Univ. of Calif.	250	22,000[b]	5.5
Riverside Bus	24	42,000	1.01
School Buses	300[b]	7,000[b]	2.10

(a) Most of this mileage is driven outside the City.
(b) Estimated on the basis of national averages.

Data were obtained on 543 of the vehicles in Riverside's city fleet. The results of calculations on these data are summarized in Table 18. These results are used in later sections. The raw data consisted of 12-month average monthly usage for each vehicle and monthly usage for each vehicle for 3 months. These data were plotted for several classes of vehicles according to number of vehicles (in each mileage interval) versus monthly mileage. No particularly striking pattern was observed. Data were also provided by the City of Riverside relative to the fuel consumption of City vehicles for the month of October, 1977. When averaged over vehicle type, however, the average fuel consumption per month and the average mileage traveled per month did not relate in any meaningful fashion. Thus, estimated fuel mileages were used, based on the estimated weight of the particular vehicle. The estimated amount of fuel consumed in vehicles in Riverside is shown in Table 19.

TABLE 18. CHARACTERISTICS OF RIVERSIDE CITY FLEET VEHICLE USAGE[a]

Vehicle Type	Number	12 Month Average Monthly Use, miles	1 Month Average Monthly Use, miles	Estimated[b] Daily Use, miles
Pickup	145	733	818	35
Scooters	54	227	197	10
Automobile	81	669	669	30
Special Equipment (winch, compressor)	82	376	437	18
Cement Mixers (Roller Grader)	16	40	46	2
Special Equipment (Flatbed, sign trk)	10	349	410	17
Water tankers	13	269	305	13
Dump trucks	42	562	542	25
Packers	34	451	526	22
Vans	23	1,037	1,171	50
Sweepers	9	694	577	29
Bus	24	4,100	--	187

(a) Excludes; tractors (7), cranes (5), compressors (1), high range, boom, compacters, loaders, D8(10).

(b) Assumes 22-day month.

TABLE 19. NUMBER OF VEHICLES AND FUEL USE FOR 1976[a]

	1976		
		Fuel Use	
	Number of Vehicles	10^6 Gallons	10^9 Btu
Private Autos and Trucks	93,631	45.7	5,480.8
Public and Fleet Vehicles	11,700	1.4	168.0
Total	105,331	47.1	5,648.8

(a) For assumptions and details concerning these data, see the calculations in Appendix C-3.

The residents of Riverside are highly oriented toward and dependent on the automobile as the means of transportation. Although there are some bus services, these alternatives are simply not feasible or convenient for most people. The bus systems are primarily used by people in Riverside who do not have access to an automobile. While Riverside does have a modest degree of locally based employment, there are large numbers of people who have chosen to live in Riverside and commute to employment located outside Riverside and outside Riverside County. This situation results in a high usage of gasoline. Gasoline is a fuel which must be used less, and, ultimately, it is a fuel upon which we can no longer be as dependent. The best method of reducing fuel usage is to use transportation other than the personal automobile. The alternatives that are available to the people of Riverside are briefly discussed below.

Car Pool/Van Pool Programs. The car pool program is a five-county-wide, state-supported program. A commuter who wishes to "car pool" can be helped through this program. A van pool program is also available, but it has had problems getting enough riders and drivers with similar transportation needs. The car/van pool programs have been available to the people in Riverside and surrounding counties for some time now. A detailed description of these programs will not be given here since complete descriptions are available at the program offices. These programs are not popular, and it is debatable whether they can be called a success in Riverside.

Car and van pooling, especially to and from work, or shopping with a neighbor, is one of the best ways that the people of Riverside can reduce fuel. However, these fuel savings are far from being realized. People are simply not willing to put up with the inconvenience of pooling (this is generally true across the United States). A means to compel the American people into pooling without being forced by a crisis situation has eluded and frustrated pooling proponents for years. A variety of incentives have been tried in this country, and in a few cases these incentives have met with some success, such as the car/van pool express lanes into Washington, D.C. from Northern Virginia. However, no incentive has really been universally successful. Consequently, widespread pooling has not occurred in Riverside nor in the rest of the United States. However, car pools and van pools are viable and important transportation alternatives.

Public Transit. The Riverside Transit Agency provides a bus service within the City of Riverside which primarily caters to those people who do not have access to the automobile, such as students and the elderly. This service is probably also a source of transportation for some people to get to work, shopping, etc. Most likely the service could be used by more people for trips within the City, but available information suggests that a survey study would be required to determine the extent to which this service could potentially be used.

The City of Riverside is included in the Rapid Transit District (RTD), and there is some bus service from the City to the surrounding cities and counties. This service is limited and the routes are not convenient for most people in Riverside who work in and commute to the surrounding cities and counties. Consequently, this service, in its present form, is a limited transportation alternative for most people.

There is also a Dial-a-Ride program for the elderly and handicapped, but this service is not a transportation alternative for the people of Riverside. The hydrogen bus experiment* is a part of this program. As stated previously, an alternative fuel may be the ultimate answer to our transportation needs. The hydrogen bus is the beginning of experiments with alternative fuels. It remains to be seen whether the bus will demonstrate that hydrogen can be used in a cost-effective manner.

Bicycles, Mopeds, Motorcycles, and Walking. These alternative methods of transportation are available to the people of Riverside, but are not practical for most transportation needs. Certainly those people who can use these alternatives for getting to work and shopping near to their homes should do so. It is cheaper and can be healthier than using the personal car.

In recognition of the role bicycling can play in a transportation system, the City of Riverside has developed a Master Plan of Bikeways. In 1973, the City commissioned a study to define and recommend a bicycle system designed to increase the safety of bicyclists and to encourage the use of the bicycle as a mode of transportation, as well as a form of recreation. This study was completed in April, 1975. The proposed Master Plan of Bikeways consists of (1) commuter and general-purpose bike routes, and (2) recreational routes.

Since then, the City has taken a number of steps to implement the Master Plan of Bikeways. Commuter bike routes have been established on (1) Magnolia Avenue, between Jurupa Avenue and Riverside City College; (2) California Avenue, generally between Jefferson Street and MacArthur Road; (3) Linden Street, between Chicago Avenue and Canyon Crest Drive; Canyon Crest Drive, between Blaine Street and University Avenue; (5) Big Springs Road, between UCR and Mt. Vernon Avenue; (6) Watkins Drive, between Blaine Street and Valencia Hill Drive, and between Picacho Drive and the Escondido Freeway; and (7) La Sierra Avenue, generally between Five Points and the Riverside Freeway. All of these routes have been established as commuter facilities with the exception of the Linden Street bike route, which consists of both recreational and commuter facilities. A recreational bikeway has also been established along Victoria Avenue, between Van Buren Boulevard and Myrtle Street, a distance of 5-1/2 miles.

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* Presently, as discussed later, the City of Riverside is conducting an experiment using a hydride-storage hydrogen-powered bus. This experimental vehicle has suffered problems and has not been subjected to prolonged use.

The Legal/Institutional Environment

Public Sector Institutions

An assessment of the existing institutional environment is essential to integrated community energy planning. Attention was confined primarily to public sector institutions, which most directly impact energy development in the Riverside community. Although some reference is made to private sector organizations, such as Southern California Edison, Battelle maintains that the most immediate and measurable opportunities for promoting alternative energy systems rest with local and state government institutions. The roles of the Federal Agencies such as the Nuclear Regulatory Commission, the Federal Power Commission, and the Environmental Protection Agency do, of course, impact the energy future of Riverside. From a policy design and implementation standpoint, however, these agencies fall outside the set of institutions with which the Riverside community may plausibly exert some direct influence.

Within the subset of all local and state public sector institutions which impact energy policy in Riverside, each may be viewed as either a major or minor actor. Among the former are: the Riverside Public Utilities Department (RPUD), the Riverside Planning Department (RPD), and the California Energy Resources Conservation and Development Commission. The minor actors are: The Riverside County Government and the Southern California Council of Governments. In the following discussion the authority, roles and policy implications of each institution are evaluated. (For more detail see Appendix E.)

The Riverside Public Utilities Department (RPUD). The RPUD is one of 12 departments within the Riverside City Government (Figure 20). The RPUD is charged with the supply of electricity and water to all areas within the City's jurisdiction.

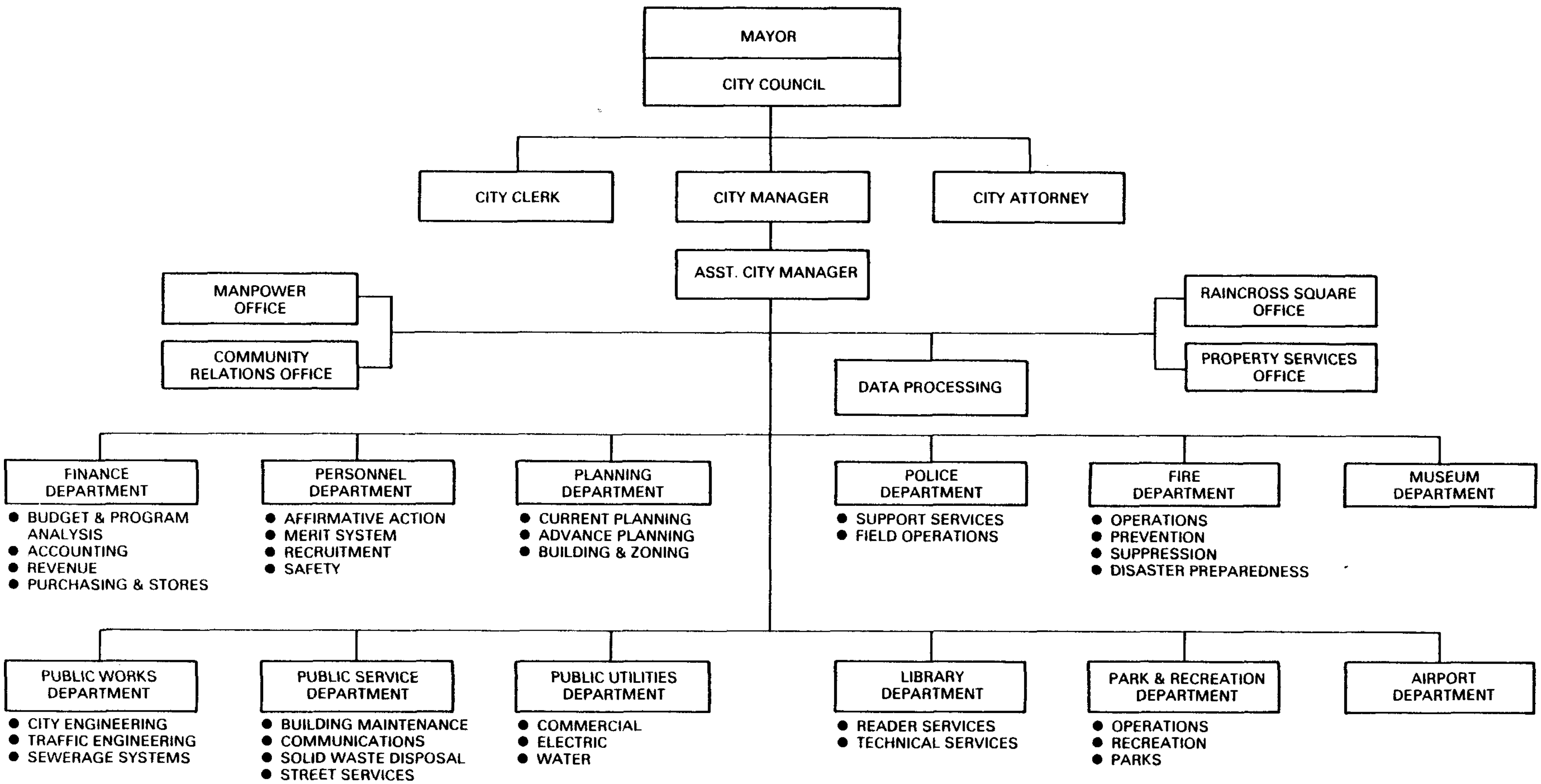


FIGURE 20. RIVERSIDE CITY GOVERNMENT ORGANIZATION

A five-person Public Utilities Board appointed by the City Council governs the operation of the Department, including its budgeting, capital expenditures, and rate-setting (subject to Council approval) activities.

RPUD's electric system operates as a subtransmission and distribution system for wholesale power purchased from Southern California Edison (SCE) and, since 1976, the Nevada Power Company. All transmission is handled by the SCE system that connects to the City's 66,000-volt transmission system for distribution throughout the municipality. In 1976, the system consisted of 1,041 circuit miles of lines, including street lights. A total of 56,902 customers are served, of which 91.8 percent are domestic, 7.6 percent commercial, and 0.3 percent industrial. Domestic customers, as a percentage of all customers have increased consistently between 1962 and 1976. Total kilowatt usage has increased 225 percent since 1962 and 23.7 percent since 1970. As in the case of total customers, domestic consumption as a percentage of total consumption has steadily increased. Operating revenues in 1976 totalled $33.2 million, as compared to $5.3 million in 1962 and $10.8 million in 1970.

The financial performance of the RPUD is crucial to the overall fiscal position of the City Government. First, RPUD's investment in nuclear generation represents the largest capital expenditure in Riverside's FY 1977-78 budget of $136.6 million. An investment of $28 million in the San Onofre Generating Plant alone represents 48.9 percent of the proposed capital improvements budget of $57.3 million. An additional $1.8 million is budgeted for the new Jurupa substation and related facilities. Of the City's total debt service budget of $7.9 million, electric utilities account for $2.1 million, or 26.6 percent. The bond issue of $4.7 million in 1966 was the first issue since 1900. Since 1962, 64.1 percent of a total $36.5 million in capital improvements has been financed from current revenues, reflecting the financially sound and conservative mode of operation characteristic of RPUD.

Besides the general budgetary impact of the municipal electric system, the City's General Fund receives an annual transfer of 11.5 percent of the electric utility's gross operating revenues.

This transfer totaled $2.7 million in 1976, an increase of 115 percent since 1970. This reflects the rapid increase in the wholesale price at which RPUD purchases electricity from SCE. The Department estimates a transfer of $3.5 million in FY 1977-78, which exceed the taxes a privately owned utility would pay on the existing system by an estimated 2.8 million. Under the current arrangement, the electric fund transfer provides approximately 16.9 percent of FY 1977-78 estimated General Fund revenues. In addition, the City imposes a 5 percent utility users tax.

In summary, the municipal electric utility is a key component in the City's fiscal system. Next to property and sales taxes, the annual transfer is the largest source of revenue to the City's General Fund. Revenues from sales of electricity are the single largest source of revenues from any source, and the utility's capital expenditures represent nearly half of all budgeted outlays. By virtue of its fiscal position and bonding authority, RPUD can play a key role in the development of a number of alternative energy sources for the Riverside Community.

A number of policy implications may be derived from the preceding discussion:

(1) RPUD can play a pivotal role in achieving the avowed objectives of greater independence from Southern California Edison.

(2) RPUD can play a pivotal role in the development of alternative fuels.

(3) RPUD is in a position to develop and implement conservation programs.

The existence of a municipal utility in Riverside represents a major advantage to the community in its efforts to implement alternative energy supply systems, promote conservation, and achieve greater energy stability and independence. RPUD is a key actor in both building a public consensus in support of an alternative energy strategy and implementing the specific programs that collectively comprise that strategy. Within the limitations of its existing mandate and authority, RPUD possesses many of the capabilities necessary for realizing the community's energy goals. Where such capabilities are lacking, ample opportunity exists for collaborative efforts with other municipal agencies. One such agency is the Planning Department, the subject of the following discussion.

The Riverside Planning Department. The Riverside Planning Department (RPD) is one of 12 functional departments within the City Government. In 1977-78 the RPD budget totaled $827,644, covering 43 employees distributed among four major programs: Administration, Advance Planning, Current Planning, and Building and Zoning. The RPD, by virtue of its planning, zoning, and inspection functions plays a key role in shaping urban development and, thereby, energy consumption patterns and levels in the City.

In a variety of ways, the authority, decisions and recommendations of the RPD partially determine the levels and spatial distribution of energy demand in Riverside. Virtually every action taken by the Current and Advance Planning programs generates energy impacts, although such impacts are not explicitly incorporated into the planning or environmental review process.

These impacts are summarized in Table 20 according to programs, major responsibilities, activities, and scale of impact.

TABLE 20. ENERGY IMPACTS OF PLANNING DEPARTMENT PROGRAMS

Program	Major Responsibilities	Activities with Direct Energy Impacts	Scale of Impact
Advanced planning	General plan	Annexation, growth management	Community-wide, major subareas
Current planning	Zoning, Subdivision controls Community design	Residential, commercial, industrial land use	Subdivision tract
Building and zoning services	Permits, inspection	Building codes	Individual structure

The Advance Planning Program impacts total energy consumption through its responsibility for preparation and revision of the General Plan. Specifically, annexation and growth management activities are the two key activities by which population growth is controlled and distributed across the city. (Significant annexation by Riverside has not occurred since the 1960-70 period when the City's area grew from 43.59 square miles in FY 1960-1961 to 71.52 square miles in FY 1970-1971.[45] Its present area is 71.58 square miles.)

Growth management is an activity of post-1970 origin resulting from public concern with total population which has increased 94 percent since 1960. While land area during the same period increased by 64 percent, most residential development occurred in peripheral areas through the conversion of land from agricultural to residential use. This issue is the focal point of the current controversy over the proposed public service point system for controlling additional residential development.[46] The nature of the system, and the stringency with which it is enforced, will have wide-ranging impacts on total energy consumption. (It is worth noting that an energy criterion is not contained in the proposed point system).

In contrast to Advance Planning, the Current Planning program operates primarily at the subdivision level through its zoning and community design responsibilities. Through its control over the spatial distribution of residential, commercial, and industrial development site plans, subdivision layouts, and zoning ordinances, Current Planning is a key actor in determining the per-capita energy consumption of Riverside households. Its policies actually or potentially generate substantial energy impacts, although--as in the case of Advance Planning--these impacts are not explicitly recognized. Among the most prominent are:

- the solar access of individual housing units through regulation of orientation, landscaping and setback distance
- the availability and promotion of bikeway plans.

Through these responsibilities, actions taken by Current Planning are crucial to achieving the full solar heating and cooling potential in the City, as well as reducing the length of trips and altering the modes of transportation to places of work and shopping.

Building and Zoning Services is the third major component of the RPD. It serves primarily in an enforcement role through its authority to issue permits and inspect buildings for conformance to local and State codes. Its responsibility has increased in the aftermath of the new State energy code that will require an increase in manpower of its inspectors. Although this program is not involved with policy development, the effectiveness with which it executes its permit and inspection functions is a key determinant of the energy efficiency of Riverside's building stock.

The California Energy Resources Conservation and Development Commission. The California Energy Resources Conservation and Development Commission (CERCDC) was created by the State to streamline the maze of energy planning and siting requirements in California. Under the Warren Alquest Act of 1974 (Assembly Bill No. 1575) the commission is charged with numerous key responsibilities, the most pertinent of which are:

- Forecasting energy demand and supply for the State.
- Conserving energy resources by designated methods.
- Certifying electric power sites and facilities.
- Compiling--and where appropriate, adopting--relevant local, regional, state, and federal land use, public safety, environmental and other standards to be met in designing siting and operating facilities in the State, except for air and water quality standards.
- Studying and rendering findings on the state of development, and federal approval, of a demonstrated technology or means for the disposal of high-level nuclear waste.

All thermal electric power plants with a capacity of 50 MW or more fall under CERCDC's jurisdiction. The only exceptions are those plants for which, at the time of enactment, (1) the Public Utilities Commission had issued a Certificate of Public Convenience, or (2) construction was planned to commence within 3 years. Although the Sundesert Plant was included in this exempted group, subsequent amendments to the act concerning nuclear waste disposal requirements (Section 25524.2) were, in the Commission's view, not fulfilled and this was the cause for rejection of the San Diego Gas and Electric's (SDG&E) plant.

The relationship of CERCDC to existing regulatory agencies is still evolving and subject to some interpretation. Although the enabling legislation grants CERCDC virtually exclusive authority in the mandated responsibilities noted above, its authority does not override existing standards of design siting and operations issued by other local, regional, State, and Federal agencies. Its powers are further limited by the (PUC) Public Utilities Commission (PUC) and the Coastal Zone Conservation Commission (CZCC). The PUC retains the authority, through its certificate of public convenience and necessity, to judge the economic, financial, rate system reliability, and service implications associated with new power plants of greater than 100-MW capacity proposed by investor-owned utilities. (The PUC exercises no authority over municipal utilities.) The CZCC retains authority to review and approve new plants located within 1,000 yards of the coastline. Thus, although CERCDC grants exclusive authority to new plants, either the PUC or CZCC may reject a new facility under its own authority. In the case of the PUC, the review occurs after CERCDC's ruling; in the case of the CZCC, the review and judgement precedes that of CERCDC's.

The Riverside County Government. Riverside County contains approximately 540,000 people and covers an area of 7,310 square miles. In FY 1976-77, the County's budgeted expenditures totaled $180 million. Public assistance accounted for almost 40 percent of all expenditures public protection, 22 percent; and general government 17 percent. On the revenue side of the budget, property taxes accounted for 27.0 percent and intergovernmental transfers, 55.4 percent of total revenues. Thus, the County government fits the typical expenditure/revenue mould of county governments throughout the nation, acting primarily as a provider of social and public protection services financed largely through property taxes and State and Federal transfers.

As a result of rapid urbanization in unincorporated areas, only recently has the County begun to assume significant responsibilities in the provision of traditionally municipal services. This evolving role will have a significant impact on the rate and pattern of land development in the County and the City of Riverside. County land use and zoning policies, for example, affect the relative attractiveness of Riverside City for new residential development. Insofar as County policy permits large-lot, quasi-agricultural developments adjacent to the City, developers will continue to concentrate new housing within the City limits. However, should developmental pressures combined with the economics of service provision compel the County to revise its land use policy toward more conventional tract developments, relatively inexpensive land in unincorporated areas may siphon off a substantial portion of current development pressures within Riverside. In this way, County planning policy will impact the continuation of Riverside's recent demographic trends and, therefore, its future energy demand profile.

Riverside County also exerts influence over the City's energy future in a second way: the exploitation of local geothermal resources for nonelectrical purposes. Although the most promising nearby resource for potential space and process heating is Arrowhead Hot Springs in San Bernardino County, other lower temperature resources are located in Desert Hot Springs and at least 20 other sites within 50 miles of the City (See Appendix D-3). Although the specific procedures for geothermal development in California are still not completely delineated, the experience of recent years suggests that county governments will exercise jurisdiction over all surface impacts (except water quality) and in this capacity, grant the initial drilling permits for exploration. To date, the willingness of counties to permit geothermal wells has varied widely.[(47)] In Sonoma County, geothermal development provides the single largest source of tax revenue, and officials have permitted fairly intense development within the federal KGRA portion of the County. Imperial County has been even more supportive of geothermal development; Napa Valley, on the other hand, has been cautious and a few years ago imposed a moratorium on new wells. In any case, the variation in County attitudes reflect a mix of factors: the compatibility of geothermal development with the dominant economic activities, the level of environmental awareness and potential damage, and the local supply of alternative fuels. To date, Riverside County has not been compelled to squarely face those issues with a comprehensive policy. However, such decisions probably will be required in the near future if the geothermal option becomes increasingly competitive. Given the size and diversity in the County, a consensus may be difficult to achieve. The City of Riverside's future energy alternatives will be directly affected by the geothermal policies that finally emerge.

The Southern California Council of Governments(SCAG). SCAG is the A-95 review agency for five counties in the Los Angeles Metropolitan area: Ventura, Los Angeles, San Bernardino, Orange, and Riverside. Approximately 150 municipalities and counties belong to the Association which comprises various committees responsible for policy formulation along functional lines. SCAG, like most A-95 agencies, is essentially a coordinative and advisory body to its members, with no authority to mandate adoption of, or conformance with, its policies at the local level.

In mid-1977, SCAG created an ad hoc Energy Advisory Committee that has since evolved into the Energy Technical Committee (ETC). The ETC serves as an advisor to SCAG's Environmental Quality and Resource Conservation Committee and the Transportation and Utilities Committee, as well as other SCAG committees on an as-needed basis. Specifically, ETC

- facilitates information exchange among all levels of government, including A-95 prepublication review of draft Federal regulations
- provides policy advice and recommendations on areawide energy policies to SCAG's Executive Committee and its policy committees
- reviews and comments on SCAG energy documents
- informs and educates regional elected officials, technicians, and citizens of the region on energy issues.

ETC members are State, Federal , and local energy officials and planners from offices within SCAG's jurisdiction.

The creation of the ETC reflects SCAG's recognition for a regional approach to energy issues. ETC in its role as disseminator of energy information can provide Riverside with data on current developments in energy conservation in the South Coast area. It may also assist the RPUD in keeping abreast of innovations among other municipal utilities such as Burbank, Glendale, Pasadena, and Los Angeles City. These municipals, in contrast to Riverside, are power generators as well as distributors, and represent a source of experience which may guide RPUD toward entry into the energy production activities. ETC and SCAG provide an available forum for municipals to organize a cohesive policy in dealing with the private utilities in issues concerning, for example, cogeneration, wheeling, and joint exploration of alternative energy resources.

In addition to these activities, SCAG is the logical agent for encouraging regional solutions to a number of energy related problems. These include:

- Developing model energy conservation programs for jurisdictions to encourage workable standards that minimize the impacts of competitiveness for new economic and residential activity.
- Developing model solar access ordinances specific to the needs of Riverside and other South Coast cities.
- Encouraging the adoption of an energy element in local general plans and providing technical assistance for implementation of the same.

These are three of the more obvious opportunities for SCAG involvement in energy planning from which Riverside could directly benefit.

In August 1978, SCAG completed a preliminary draft "Air Quality Management Plan" (AQMP). Generally, the Plan presents an approach that brings together both an air quality management agency with regulatory powers, and land use and transportation planning agencies in a comprehensive planning effort. Specifically, the plan is designed to:

(1) identify allowable emissions necessary to have clean healthful air quality

(2) provide a comprehensive program to meet the public's right to clean air by 1987 through reasonable, cost conscious, incremental actions by agencies at all levels of government

(3) meet the requirements of the California Lewis Air Quality Management Act

(4) meet the requirements of the Federal Clean Air Act, as amended in 1977.

Failure to implement the Plan can result in Federal enforcement of the Plan and imposition of Federal sanctions against the funding and approval of virtually all Federally-funded projects, especially transportation and waste water treatment projects.

Environmental Quality

Air Pollution Regulation

A major impetus toward the control of air pollution in the United States was passage of the Clean Air Act Amendments of 1970. These amendments required that each state promulgate a plan for implementing air pollution controls which would result in the attainment of ambient air quality standards by 1975. The pollutants for which national ambient standards were established were airborne particulate matter (also called total suspended particulates), sulfur dioxide, carbon monoxide, nitrogen dioxide, nonmethane hydrocarbons, and photochemical oxidants. For particulates and sulfur dioxide, there are national primary and secondary standards. The primary standards are based on criteria that will ensure protection of human health while the more restrictive secondary standards would also protect vegetation, materials, animals, and visibility from air pollution damage. In establishing the ambient standards, various averaging time for measuring the pollutants are used, ranging from 1 hour to 1 year depending upon the criteria periods that were used in the original pollution damage studies.

States have the option of establishing their own ambient standards for the pollutants regulated nationwide as well as for other air pollutants. The National and California ambient air quality standards are listed in Table 21. It can be noted that California has ambient standards for lead, sulfates, hydrogen sulfide, and visibility in addition to standards for some of the six "criteria" pollutants which differ from the Federal standards.

Another set of standards has been established to protect against imminent danger to human health from a buildup of atmospheric pollutants under adverse meteorological conditions. During these air pollution episodes the normal dispersion of pollutants is hindered by low wind speeds and temperature inversions. Table 22 lists the ambient pollutant concentrations at which different stages of episodes are declared in California and in the South Coast Air Basin. The South Coast Air Basin comprises Los Angeles County, Orange County, and western portions of San Bernardino and Riverside Counties.

TABLE 21. CALIFORNIA AND NATIONAL AIR QUALITY STANDARDS

Air Contaminant	Air Quality Standards[a]: California	National[b]: Primary	National[b]: Secondary
Photochemical Oxidants (O_3)	0.10 ppm, 1 hr avg	0.08 ppm ($160\ \mu g/m^3$) 1 hr avg	0.08 ppm ($160\ \mu g/m^3$) 1 hr avg
Carbon Monoxide (CO)	10 ppm 12 hr avg	9 ppm ($10\ mg/m^3$) 8 hr avg	9 ppm ($10\ mg/m^3$) 8 hr avg
	40 ppm 1 hr avg	35 ppm ($40\ mg/m^3$) 1 hr avg	35 ppm ($40\ mg/m^3$) 1 hr avg
Nitrogen Dioxide (NO_2)	0.25 ppm 1 hr avg	0.05 ppm ($100\ \mu g/m^3$) AAM	0.05 ppm ($100\ \mu g/m^3$) AAM
Sulfur Dioxide (SO_2)	0.04 ppm 24 hr avg	0.14 ppm ($365\ \mu g/m^3$) 24 hr avg	0.50 ppm ($1300\ \mu g/m^3$) 3 hr avg
	0.50 ppm 1 hr avg	0.03 ppm ($80\ \mu g/m^3$) AAM	
Particulate Matter	$100\ \mu g/m^3$ 24 hr avg	$260\ \mu g/m^3$ 24 hr avg	$150\ \mu g/m^3$ 24 hr avg
	$60\ \mu g/m^3$ AGM	$75\ \mu g/m^3$ AGM	$60\ \mu g/m^3$ AGM
Lead (Pb)	$1.5\ \mu g/m^3$ 30 day avg		
Nonmethane Hydrocarbons		0.24 ppm ($160\ \mu g/m^3$) 3 hr avg 6-9 a.m.	0.24 ppm ($160\ \mu g/m^3$) 3 hr avg 6-9 a.m.
Hydrogen Sulfide (H_2S)	0.03 ppm 1 hr avg		
Visibility Reducing Particles	In sufficient concentration to reduce visibility to less than 10 miles at relative humidity of less than 70%		

(a) Standards shown in parenthesis are restatements of the preceding standard but expressed on an alternative basis.
(b) Concentrations other than annual averages not to be exceeded more than once a year.

Source: "Air Quality and Meteorology", 1975 Annual Report of the Southern California Air Pollution Control District, R. W. Keith, Editor.

TABLE 22. CALIFORNIA AIR QUALITY EMERGENCY STANDARDS

Air Contaminant	Stage 1 Health Advisory	Stage 2 Warning	Stage 3 Emergency
Photochemical Oxidants (O_3)	0.20 ppm 1 hr avg	0.35 ppm 1 hr avg	0.50 ppm 1 hr avg
Carbon Monoxide (CO)	20 ppm 12 hr avg	35 ppm 12 hr avg	50 ppm 12 hr avg
	40 ppm 1 hr avg	75 ppm 1 hr avg	100 ppm 1 hr avg
Sulfur Dioxide (SO_2)	0.20 ppm 24 hr avg	0.70 ppm 24 hr avg	0.90 ppm 24 hr avg
	0.50 ppm 1 hr avg	1.0 ppm 1 hr avg	2.0 ppm 1 hr avg
Actions to be Taken	Voluntary reduction in physical activity.	Action ranges from voluntary to mandatory.	Mandatory abatement measures. State can take action if local efforts fail.

Source: "Air Quality and Meteorology", 1975 Annual Report of the Southern California Air Pollution Control District, R. W. Keith, Editor.

Clean Air Act Amendments of 1977

While considerable progress in the reduction of air pollution was made as a consequence of the 1970 Clean Air Act Amendments, the National Ambient Air Quality Standards were not attained throughout the country by 1975. It was found that tighter controls would be required to meet these standards and that the State Implementation Plans should also be revised to include methods for maintaining good ambient air quality in the future. The Clean Air Act Amendments of 1977 have set out revisions to the 1970 methods and schedule for attaining and maintaining air quality.

Some of the requirements of the 1977 Amendments which are important to the implementation of an energy plan for Riverside include:

- The designation of areas where air quality does not meet ambient standards as "nonattainment" areas with restrictions on any new sources of air pollutants proposed for those areas.
- The issuing of guidelines to the states and local pollution control agencies demonstrating how they can reduce carbon monoxide and photochemical oxidant precursors from motor vehicles through transportation control measures such as car pools, parking restrictions, promotion of mass transit, fuel conversion, etc.
- Identification of fossil-fuel-fired steam electric plants which have more than 250 million Btu per hour heat input and which produce 100 tons per year or more of any air pollutant as two examples of "major emitting facilities". These facilities would require special analysis regarding air pollution impact before they could be constructed in a nonattainment area. One requirement is that attainment of air quality standards must be shown and another is that before

a new source can emit pollutants, its pollution emissions must be offset by an equivalent or greater reduction in emissions from an existing source in the area.

- The requirement that a new source must comply with the lowest achievable emission rate of pollutants.
- The requirement that State Implementation Plan revisions must demonstrate that national primary ambient air quality standards will be achieved by December 31, 1982. It is possible for this deadline to be changed to December 31, 1987, for photochemical oxidants and carbon monoxide if the state can show that attainment is not possible for these two pollutants by 1982 despite the implementation of all reasonably available measures.
- A revision of new source performance standards for steam generating units which will impose percentage reduction requirements for sulfur dioxide, nitrogen dioxide, and particulate matter emissions without regard to the type of fuel burned.

Attainment and Nonattainment Areas. Figure 21 is a map delineating the boundaries that separate the South Coast Air Basin from the Southeast Desert Air Basin on the north and east. Ambient concentrations of total suspended particulates, carbon monoxide, nitrogen dioxide, and oxidants measured in the South Coast Air Basin during the eight quarters preceding August, 1977 (the month of enactment of the 1977 Clean Air Act Amendments), were higher than the primary standard concentration. As a result, the entire South Coast Air Basin was designated as a nonattainment area for these four pollutants. Sulfur dioxide concentrations were found to be lower than national standard concentrations so this air basin is an attainment area for SO_2. For oxidant, the nonattainment designation includes all of eastern Riverside County as well as the western portion where the City of Riverside is located.

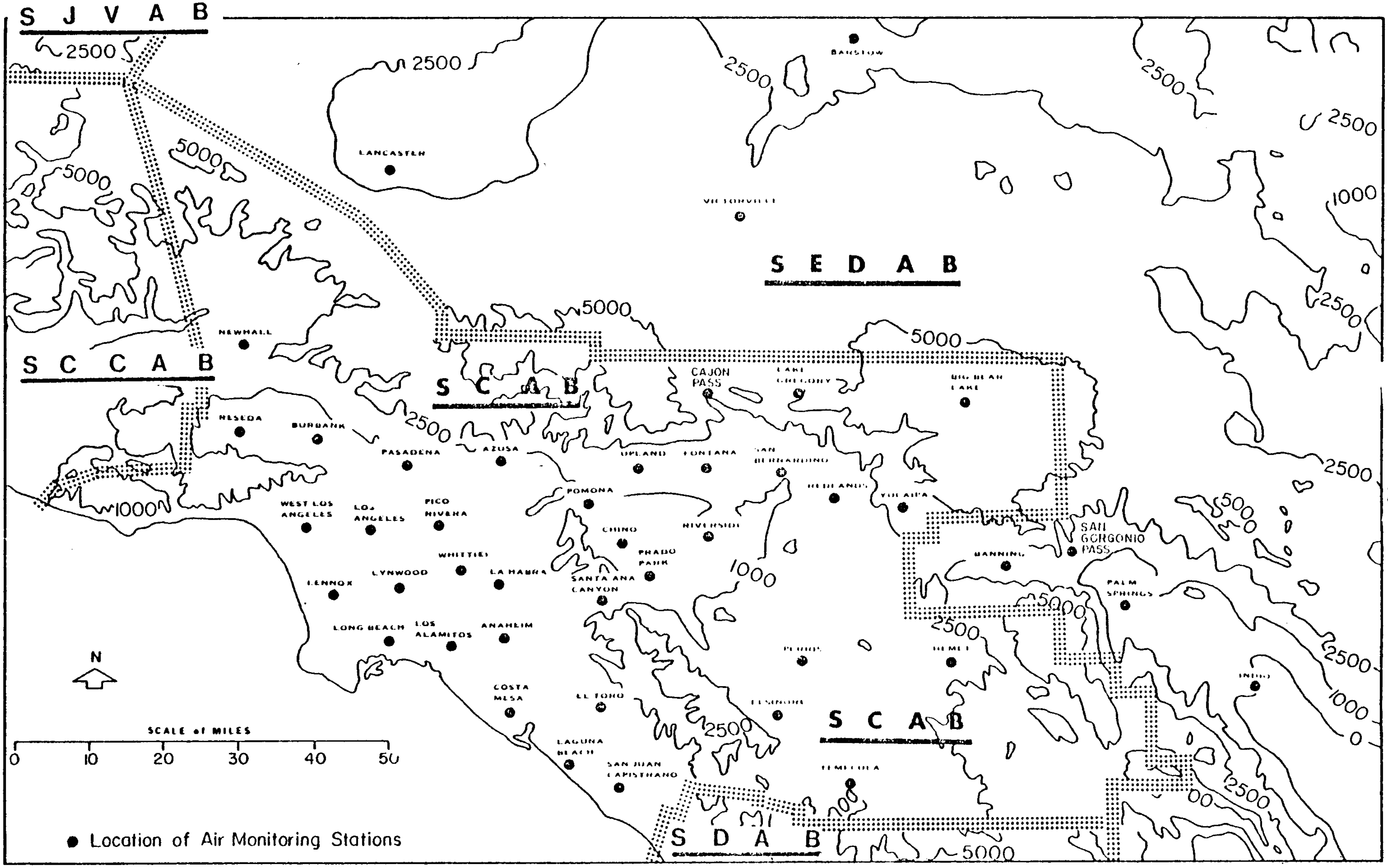


FIGURE 21. AIR BASINS, MONITORING STATIONS, AND TERRAIN IN THE AREA SURROUNDING RIVERSIDE. (Terrain Heights are in thousands of feet. SCAB = South Coast Air Basin, SEDAB = Southeast Desert Air Basin, SDAB = San Diego Air Basin, SCCAB = South Central Coast Air Basin, SJVAB = San Joaquin Valley Air Basin.)

Riverside County from the Los Angeles County border to the Coachella Valley (Indio) is also a nonattainment area for particulates. However, with respect to sulfur dioxide, nitrogen dioxide, and carbon monoxide, these concentrations in the portion of Riverside County outside of the South Coast Air Basin have been found to be lower than national standard concentrations or cannot be classified because of insufficient measurements.

Trends of Individual Pollutants. On the basis of the frequency with which ambient standards are exceeded, oxidant is the most troublesome pollutant in the South Coast Air Basin. Furthermore, Riverside is one of the stations with the highest number of excessive readings (Figure 22). The pattern of excessive concentrations reveals that the highest oxidant concentrations do not occur over the most densely populated portions of the basin, but further inland. This is the result of the time required for the photochemical change which converts nitrogen oxides to oxidant. During this period of several hours, the air mass into which the pollutants were emitted has been transported inland by the daytime breeze from the ocean.[48] In 1976, there were 176 days when the State standard of 0.10 part per million was not met at the Riverside monitor. In 1977, the number of violation days increased to 193. Episode days in Riverside over the past 3 years are tabulated below.

Number of Oxidant Episode Days in Riverside

	Stage 1 (≥0.20 ppm)	Stage 2 (≥0.35 ppm)
1975	61	2
1976	46	2
1977	66	1

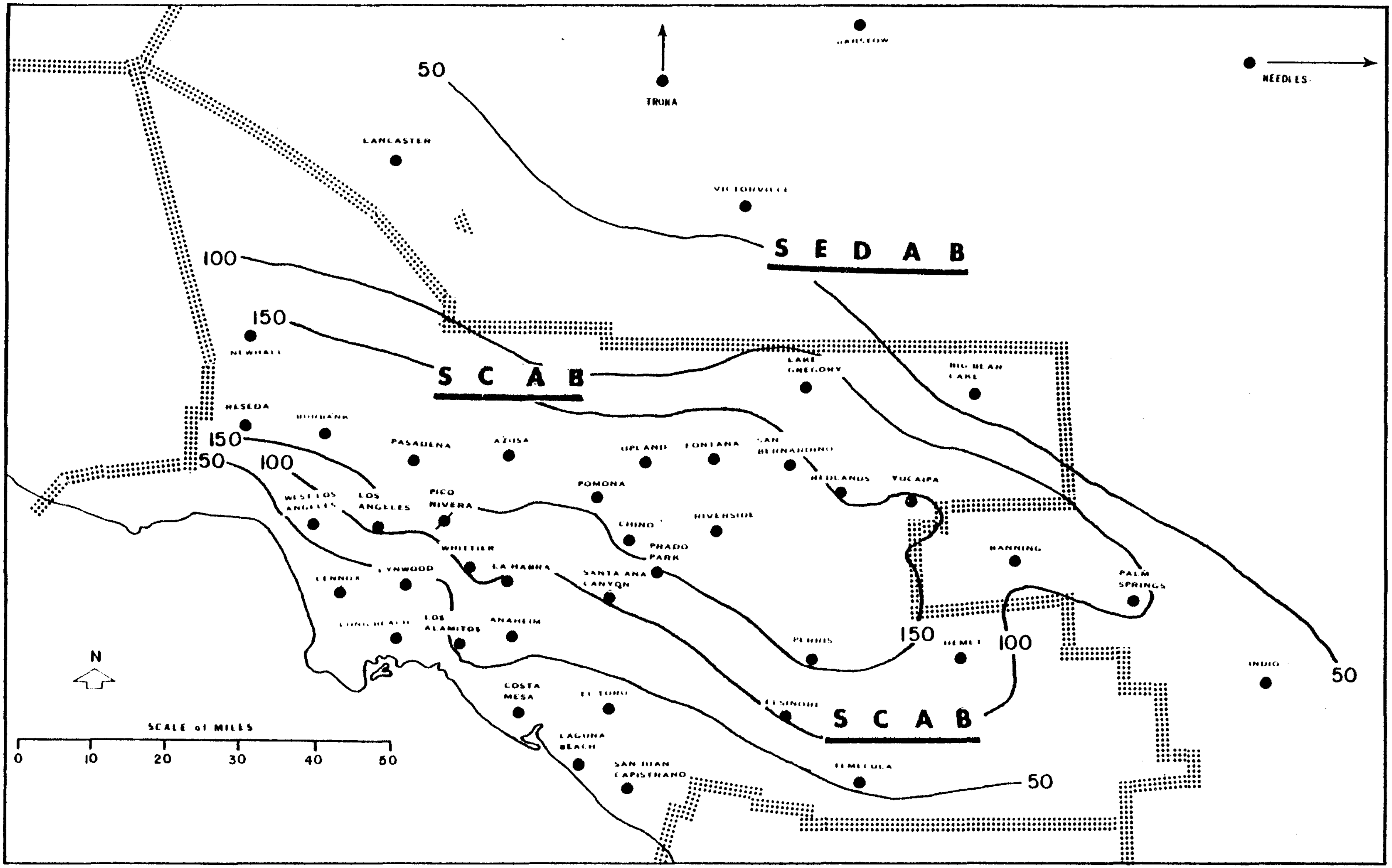


FIGURE 22. NUMBER OF DAYS IN 1976 ON WHICH STATE OXIDANT STANDARD (1-HR. AVG. $O_3 \geq 0.10$ ppm) WAS VIOLATED

Source: "Contour Maps of Air Quality in the South Coast Air Basin -- 1976" South Coast Air Quality Management District, July, 1977; M. Hoggan, A. Davidson and M. F. Brunelle

Riverside is also in an area of the South Coast Air Basin where particulate concentrations frequently exceed the standard (Figure 23). While there is a major industrial source of particulates northwest of Riverside, there may also be significant contributions from windblown dust in this desert climate. Minor portions of the particulates include soot, sea salt, lead, sulfate, organic matter, and nitrates.

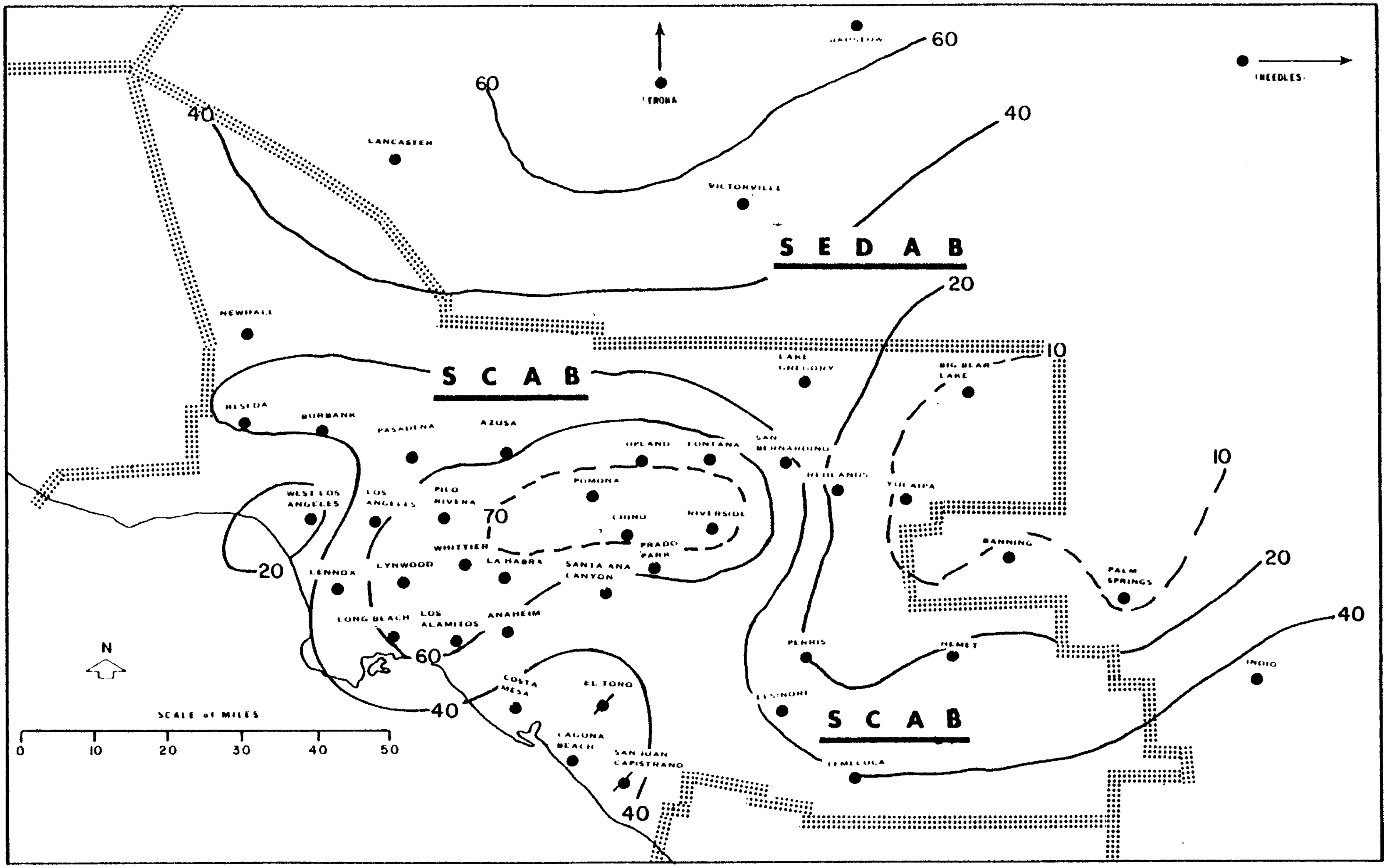
The following tabulation presents the record of total suspended particulates (TSP) measurements at the Riverside stations since 1971.

TSP 24-Hour Measurements (mg/m^3) at Riverside

Year	Number of Observations	Minimum	Maximum	Geometric Mean
1971	34	42	384	137.2
1972	38	40	359	136.2
1973	34	55	652	161.7
1974	76	39	259	134.5
1975	98	24	272	127.4
1976				
1977	NA*	35	508	NA*

* NA = not available.

Carbon monoxide concentrations are highest in areas that are in close proximity to heavy automobile traffic. While hourly measurements of carbon monoxide have been taken in Riverside since 1963, first at the 11th Street Mall and then at Magnolia Avenue, there have been only 6 years when the number of readings were sufficient to meet statistical criteria.



—— solid lines are at intervals of 20 ug/m^3. — — dashed lines are at intervals of 10 ug/m^3.

FIGURE 23. PERCENTAGE OF DAYS IN 1976 WHEN THE STATE TOTAL SUSPENDED PARTICULATE STANDARD (TSP $\geq$ 100 $\mu g/m^3$) WAS VIOLATED.

Source: "Contour Maps of Air Quality in the South Coast Air Basin -- 1976", South Coast Air Quality Management District, July, 1977; M. Hoggan, A. Davidson and M. F. Brunelle.

Based on this lengthy but sometimes inadequate record, there were no occasions on which the national hourly standard of 35 ppm was exceeded. However, the national 8-hour standard of 9 ppm was exceeded 120 times in 1973 and 31 times in 1975. In 1976, the California 12-hour standard of 10 ppm was never exceeded.

At Riverside, the nitrogen dioxide NO_2 annual average has always been quite close to the national standard, but with a slight increasing trend. On the other hand, the trend of the maximum 1-hour readings has been downward. As an addendum to the figure, there were no occasions in 1976 when the 1-hour maximum was exceeded; but there were 4 days in 1977 when the 1-hour concentration rose above 25 pphm. Maximum NO_2 readings at Riverside generally occur in the October-December quarter.

In the South Coast Air Basin, the greatest number of NO_2 violations (on the order of 40 or 50 days per year) occur in the western portions such as Los Angeles and Long Beach.

A limited number of measurements of sulfur dioxide were made at Rubidoux between 1966 and 1975. There were no occasions when the maximum 1-hour standard for California (50 pphn) nor the U.S. annual arithmetic average standard (3 pphm) were violated. During this period, the highest 1-hour reading (25 pphm) was observed in 1966 and the maximum annual average (2.0 pphm) occurred in 1975.

However, there have been violations of SO_2 standards in other portions of the South Coast Air Basin. In 1976, the California 24-hour standard of 4 pphm was exceeded at Fontana and in the Los Angeles area. In both areas, there are major stationary sources of SO_2 such as power plants or refineries.

Transport and Dispersion of Air Pollutants. It is becoming apparent nationwide that air pollutants can be transported a considerable distance beyond their sources. This is especially true for secondary pollutants, such as oxidant and sulfate, which are produced as a result of chemical changes in the primary emissions--nitrogen oxides and sulfur dioxide in the case of oxidant and sulfates. Nationally, recent interest in air pollutant transport is on the movement of large air masses from the Rockies to the East Coast which contain oxidants and their precursors. These air masses accumulate oxidant precursors and oxidant as they pass over an urban area; then, the next urban area and the region downwind of it must contend with this transported oxidant as well as oxidant precursors added locally.

Transport of pollutants is an important factor in analyzing Riverside's air pollution situation. Oxidant, the pollutant whose concentration is highest in relation to ambient standards, is formed as a result of the photochemical changes that nitric oxide and hydrocarbon undergo during several hours of exposure to solar radiation. When the wind is blowing, the nitric oxide emitted in one area will be transported elsewhere before the oxidant is formed. Thus, Riverside may receive some oxidant from sources in Los Angeles and Orange Counties while some of its own emissions of oxidant precursors are transported elsewhere.

Appendix F gives details of transport associated with topography, winds and temperature inversions as well as other meteorological factors contributing to transport.

Air Pollutant Emissions from Riverside, California. An air pollutant emission inventory can be prepared for an area in terms of tons of each pollutant emitted into the air each year from stacks, exhaust pipes, open burning, fugitive emission sources, and evaporation. Fugitive emissions include dust blown from storage piles or injected into the air from unpaved roads and agricultural operations, as well as pollutants that enter the air from windows, doors, and uncovered conveyors. The emission inventory does not represent the measurement of emissions from the large number of sources in the area. Rather it is the application of a set of emission factors to the actual or estimated operations of the sources such as fuel consumed, amount of raw material consumed, amount of product manufactured, and vehicle miles traveled. The emission factors represent average emissions derived from a few examples of each type of operation.

The sources can be categorized as point or area, where point sources produce a large tonnage of emissions from a single emission point, while area sources represent a small individual emission but are summed over areas the size of a square mile or more. Sources can also be divided into stationary and mobile sources where the latter category refers primarily to emissions from transportation.

An estimate of the average emissions of organic gases, particulates, nitrogen oxides, sulfur dioxide, and carbon monoxide from sources in part of Riverside County was prepared for 1975. The portion of Riverside County treated was the Western part that lies in the Southern California Air Pollution Control District (this district also includes the Western portion of San Bernardino Count, as well as all of Los Angeles and Orange Counties). Table 23 presents this emission estimate for Western Riverside County separated into contributions from various categories under stationary sources, miscellaneous area sources, and mobile sources. Air pollutants from natural sources such as windblown dust from the desert or sea salt carried into the air are not included in this summary.

When these Riverside County emissions are combined with the emissions from the other three counties, the emission inventory for the District is obtained. These total emissions are the ones that must be reduced in order to improve the air quality in the South Coast Air Basin. Table 24 lists the estimates of 1975 emissions of each pollutant from the entire district and from western Riverside County, as well as the percentage of the District's total contributed by Riverside County.* Riverside County contributes less than 10 percent of the emissions in all categories except

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* This 1975 Southern California APCD emission inventory should be considered as only a tentative approximation and guide. The District is developing better approximations. For instance, 1976 District emission estimates (in tons per day) compiled by the Southern California APCD in 1977 are as follows:

Organic Gases	Particulates	NO_x	SO_2	CO
87.6	71.5	63.6	47.2	380.9

The differences between 1975 and 1976 emmisions do not necessarily represent actual changes in emmisions between the 2 years, but rather result primarily from different methods of computing them from operation data and emission factors.

TABLE 23. RIVERSIDE COUNTY ESTIMATED AVERAGE EMISSIONS OF POLLUTANTS FOR 1975 (TONS PER DAY)

	Emissions, tons/day				
Stationary Sources	Organic Gases	Part.	NO_x	SO_2	CO
Petroleum					
Production					
Refining					
Marketing	7.5				
Subtotal	7.5				
Organic Solvents					
Surface Coating	14.8				
Dry Cleaners	1.4				
Degreasing	0.3				
Other	0.5				
Subtotal	17.0				
Chemical	0.1	0.1			
Metallurgical	0.5	8.1	13.3	41.8	3.4
Mineral		1.3	2.9		3.0
Food and AG Processing	0.4	0.9	0.2		
Pesticides	4.0				
Wood Processing					
Subtotal	5.0	10.4	16.4	41.8	6.4
Combustion of Fuels					
Refineries					
Power Plants	0.1	0.1	1.0	0.6	0.2
Industrial		0.1	1.2		0.2
Domestic & Commercial	0.2	0.1	2.3		0.6
Orchard Heaters	0.1	6.5			0.5
Subtotal	0.4	6.8	4.5	0.6	1.5
Waste Burning					
Agricultural Debris	0.3	0.2			1.0
Forest Management					
Range Improvement					
Dumps					
Conical Burners					
Incinerators		0.1			0.1
Other					
Subtotal	0.3	0.3			1.1
Total Stationary	30.2	17.5	20.9	42.4	9.0

TABLE 23. (Continued)

	Emissions, tons/day				
	Organic Gases	Part.	NO_x	SO_2	CO
<u>Misc. Area Sources</u>					
Wild Fires					
Structural Fires	1.4	1.1	0.1		4.6
Farming Operations		13.3			
Const. & Demolition		1.3			
Unpaved Roads		1.6			
Utility Equip: Mowers, Etc.	0.8				5.2
Total	2.2	17.3	0.1		9.8
<u>Mobile Sources</u>					
Motor Vehicles - On Road					
Light Duty VEH Exhaust	30.6	6.8	49.0	1.5	412.8
Heavy Duty VEH Exhaust	4.5	0.5	5.4	0.1	49.2
Diesel Powered Vehicles	2.3	1.0	22.6	1.8	14.3
Motorcycle Exhaust	2.0				5.5
Evaporation	13.0				
Subtotal	52.4	8.3	77.0	3.4	481.8
Aircraft	4.0		0.9		6.6
Railroads and Ships					
Other Off-Road Vehicles	3.4	0.3	5.0	0.7	23.4
Total Mobile	59.8	8.6	82.9	4.1	511.8
<u>Summary</u>					
Stationary Sources	30.2	17.5	20.9	42.4	9.0
Area Sources	2.2	17.3	0.1		9.8
Mobile Sources	59.8	8.6	82.9	4.1	511.8
GRAND TOTAL	92.2	43.4	103.9	46.5	530.6

Source: Unpublished tabulation by Southern California Air Pollution Control District, October, 1976.

TABLE 24. ESTIMATED CONTRIBUTION OF RIVERSIDE COUNTY SOURCES TO AIR POLLUTANT EMISSIONS IN THE SOUTHERN CALIFORNIA AIR POLLUTION CONTROL DISTRICT

Source	Emissions, tons per day				
	Total Organic Gases	Particulates	NO_x	SO_2	CO
Stationary					
Riverside County	30.2	17.5	20.9	42.4	9.0
Entire District	662.8	90.2	388.9	326.2	312.7
Percentage from Riverside	4.5	19.4	5.4	13.0	2.9
Miscellaneous Area					
Riverside County	2.2	17.3	0.1	neg	9.8
Entire District	78.4	83.8	10.7	neg	474.9
Percentage from Riverside	2.8	20.6	0.9	---	2.1
Mobile					
Riverside County	59.8	8.6	82.9	4.1	511.8
Entire District	779.9	131.2	1,085.8	73.1	6,955.5
Percentage from Riverside	7.7	6.5	7.6	5.6	7.3
Total					
Riverside County	92.2	43.4	103.9	46.5	530.6
Entire County	1,521.1	305.2	1,485.4	399.3	7,743.1
Percentage from Riverside	6.1	14.2	7.0	11.6	6.9

Source: Unpublished tabulation by Southern California Air Pollution Control District, El Monte, California, October, 1976.

particulates and sulfur dioxide from stationary sources and particulates from miscellaneous area sources. By referring to the Riverside County emission inventory listing in Table 23 one can identify the types of sources which produced these three larger contributions to the District emissions. Metallurgical operations emitted almost 50 percent of the stationary source particulates and almost 100 percent of the stationary source sulfur dioxide. Farming operations produced about three-fourths of the miscellaneous area source emissions of particulates.

A review of industry and population within the City of Riverside can narrow down the air pollutant emissions from the City as compared with those from the County and District. The major stationary point sources (those emitting over 100 tons per year of any pollutant) as included in the Southern California APCD listing are Riverside Cement (which is in Rubidoux) and Rohr Industries in Riverside. It is estimated that Rohr Industries emits over 2 tons per year (0.57 tons per day) of hydrocarbons/organic gases. This emission would be listed under Stationary Sources - Organic Solvents in Table 23. Most of the emissions categorized under Stationary Sources in the 1975 Riverside County inventory are not within the Riverside City limits.

Besides the one major point source in the City, there are numerous other smaller point sources. However, Riverside's largest contribution to the County emission inventory is the emissions that can be related to population. The City has about 35 to 40 percent of its population in the Riverside County portion of the SCAPCD. It can be assumed that this percentage of the motor vehicle, petroleum marketing, dry cleaning, and structural fire emissions in Riverside County is produced in the City. The City would also be responsible for most of the aircraft emissions listed in the inventory. The other major airports in the area--Ontario and Palm Springs--are, respectively, in San Bernardino and in the non-SCAPCD portion of Riverside County.

Another major contribution from Riverside County to the District emissions--farming operations--is produced outside the City.

Noncriteria Air Pollutants. The six air pollutants previously discussed (particulates, sulfur oxide, photochemical oxidants, nitrogen oxides, hydrocarbons, and carbon monoxide) are sometimes referred to as criteria pollutants, since before national ambient air quality standards are established the US EPA must issue the criteria that support these standards. Other substances have also been identified as pollutants. For some, such as lead, national ambient standards will soon be in effect and these substances will be added to the list of criteria pollutants. For others, national standards may be established some time in the future.

California has set state ambient standards for several air pollutants in addition to the six criteria pollutants. These additional California ambient standards cover particulate lead, particulate sulfate, hydrogen sulfide and visibility-reducing particles. Hydrogen sulfide is objectionable primarily because of its odor. Principal sources of hydrogen sulfide emissions are the oil refineries and the chemical processing industry in the South Bay portion of western Los Angeles County. Their odors do not affect Riverside.

Presented on Table 25 are the results of an analysis to determine the contribution that several substances (which are not criteria pollutants) made to the 24-hour particulate concentrations collected at three South Coast Air Basin stations between 1967 and 1973.[49] It can be seen in the Table that the sulfate percentage in the particulate catch decreases from the coast (Long Beach) to the inland stations while the nitrate percentage increases. Both of these pollutants are secondary products of anthropogenic sources and they are primarily of submicron size. Thus they contribute to the scattering of light and the reduction of visibility. The concentration percentages presented above are for the entire 24-hour period and are a year's average. Hidy et al,[50] in their California Aerosol Characterization Experiment (ACHEX) presented measurements demonstrating that secondary conversion

TABLE 25. SOUTHERN CALIFORNIA HI-VOL PARTICULATE COMPOSITIONS FOR 1967 TO 1973 FOR SEVERAL SUBSTANCES

Station	Annual Geometric Mean ($\mu g/m^3$)	Annual Arith-metic Mean ($\mu g/m^3$)	Lead ($\mu g/m^3$)	Sulfate ($SO_4^=$) ($\mu g/m^3$)	Nitrate (NO_3^-) ($\mu g/m^3$)	Ammonium (NH_4^+) ($\mu g/m^3$)	Benzene Solubles ($\mu g/m^3$)
Riverside	140	150	1.8 (1.2%)	11.7 (7.8%)	15.1 (10.1%)	1.5 (1.0%)	11.0 (7.3%)
Ontario	110	120	1.9 (1.6%)	10.2 (9.5%)	10.8 (9.0%)	1.0 (0.8%)	9.4 (7.8%)
Long Beach	95	105	2.3 (2.3%)	11.2 (10.7%)	5.6 (5.3%)	1.5 (1.4%)	10.2 (9.7%)

products such as sulfates, nitrates, and photochemical aerosols tend to be between 0.1 and 1.0 micrometers in size. They also showed that the fraction of the South Coast Air Basin Atmosphere occupied by these particulates increases sharply between early morning and midday.

Sulfur dioxide (SO_2) in the atmosphere is gradually converted to sulfur trioxide (SO_3) by a photochemical change and subsequently converted to sulfate compounds including sulfuric acid, ammonium sulfate, and lead sulfate. These compounds exist in the air as liquid droplets or solid particles. The photochemical conversion of SO_2 to SO_3 is speeded up in polluted atmospheres, specifically those containing nitrogen oxides and hydrocarbons.

Sulfur dioxide emissions are transformed to sulfate faster and more completely in the South Coast Air Basin than in any other region of the country because of the combination of abundant sunshine, polluted conditions and the poor dispersive characteristics of the Basin (the low wind speeds and the confining nature of the surrounding mountains.)* In the South Coast Air Basin 13 percent of the SO_2 emissions are transformed to sulfate each hour compared to 2 percent in most metropolitan areas of the country.[51] During the periods of maximum transformation of the SO_2 that is emitted along the Pacific Coast will be converted to sulfate by the time it travels the width of the basin. In other metropolitan areas of the country no more than 15 percent conversion might occur in this distance.

* SO_2 oxidation rates are more rapid in oil-fired than in coal-fired power plant plumes. In the first 30 miles downwind the rate is 1 to 2 percent per hour for coal-fired versus 10 to 20 percent per hour for oil-fired. The difference is believed to be due to the lack of particulate controls in the oil-fired-plant plume. Consequently, the vanadium and other catalytic particulates in the oil-fired-plant plume escape with the SO_2 and accelerate the conversion to sulfate. After 30 miles both rates are about 3 percent per hour. However, the coal plume contains higher SO_2 concentrations that can convert to more sulfate over wide areas downwind than do plumes from low-sulfur oil-fired sources.

Major sources of SO_2 in the Basin result from petroleum refining and the combustion of sulfurous fuel oils, both undertaken in Los Angeles County. There are also natural sources of sulfate of which oceanic bacteria is the major one. Decaying animal or plant tissue releases organic-sulfur-containing gases that are oxidized to sulfates. Even the natural source contribution to sulfate concentrations is greater in Southern California -- 4 $\mu g/m^3$.

Sulfate particles generally have mass mean diameters in the submicron range ($\leq$ 1.0 μm). Particles of this size are significant for two reasons.

(1) They can infiltrate the deeper regions of the respiratory system and are likely to be retained in the lungs. As a consequence they aggravate breathing difficulties and respiratory diseases. It has been found that these adverse effects are magnified when the high sulfate concentrations are concurrent with excessive oxidant concentrations and high humidities.

(2) Particles in the size range of 0.1 to 1.0 μm are most effective in reducing visibility. They have been shown to be responsible for about 20 percent of the visibility reduction in the Basin.[52]

Sulfate concentrations make up only about 10 percent (7.8 percent in Riverside) of the total suspended particulates (as analyzed between 1967 and 1973).[53] However, there is special interest in sulfates because of the possibility that there will be an increase in sulfurous fuels used in the Basin in future years. The resultant growth in SO_2 emissions coupled with the Basin's fertile conditions for transformation of SO_2 to sulfate and the presence of high oxidant concentrations in the area portend a sharp rise in sulfates and their consequent effects.

Sulfate concentrations are generally highest in the summer months of June through August and lowest during the winter months of November through February. Concentrations peak between noon and 2 p.m. in the Los Angeles Basin area; however, in Riverside the most probable time for peak sulfate concentrations to occur during the summer is between 6 a.m. and 8 a.m.[54]

Between 1965 and 1975 sulfate concentrations in the Basin reached a maximum in 1972 and then declined. The highest concentration in the Basin during this period was 84.6 $\mu g/m^3$, measured at Thousand Oaks (Ventura County) in 1972. Maximum 24-hour sulfate measurements at several sites in the Basin between 1972 and 1974 are given below.

Highest 24- Hour Sulfate Concentrations ($\mu g/m^3$) 1972-1974

Station	Maximum Concentration
Anaheim	65.8
Lennox	53.3
Los Angeles	72.2
Ontario	29.1
Riverside	31.4
Thousand Oaks	84.6
West Covina	62.5

Airborne lead in the South Coast Air Basin originates almost entirely from the combustion of gasoline in motor vehicles. Vehicle lead emissions are small particles with a mean diameter of about 0.25 μm. About half of this lead from automobile exhausts settles out of the air within 100 yards of roadways. The concentration of lead in the air is closely correlated with the density of traffic. Over 63,000 cars daily use the Riverside Freeway that has houses or apartments on one or both sides in the 5-mile stretch between Van Buren Boulevard and 14th Street.[55] The site of the lead monitoring station at Magnolia and Arlington Avenues is about 1200 meters from the Riverside Freeway.

The major source of human exposure to lead is from ingestion of food and water. However, in urban areas, especially near freeways, where atmospheric lead concentrations are high, inhaled lead is a notable source of body lead. This stems from the fact that a greater percentage (20 to 50 percent) of inhaled lead versus that of injected lead (5 to 10 percent) is absorbed by the body. In blood level studies of urban versus rural populations the most noticeable increases are among children. Long exposure to lead concentrations above 2 to 3 $\mu g/m^3$ can result in an accumulation of lead in the blood. Acute forms of toxicity, such as cramps and nervous sytem effects, can occur when lead levels in blood are high.

The California Air Resources Board has set the ambient lead standard at 1.5 $\mu g/m^3$ for a monthly average. In 1975 and 1976 this standard was exceeded at the Riverside monitoring site (Magnolia and Arlington Avenues) in every month except one and then the monthly average was 1.47 $\mu g/m^3$ (Table 26). In most months the concentration was over 2 $\mu g/m^3$. By comparison the monthly lead concentrations in Rubidoux exceeded the standard in 9 of 23 months during this period with five values above 2 $\mu g/m^3$. Maximum lead concentrations occur in winter. The higher winter lead concentrations have been attributed to the lower heights of the temperature inversion base in those months. During 1976 the maximum 24-hour averages of lead concentrations occurred in December (6.73 $\mu g/m^3$) and November (6.40 $\mu g/m^3$).

With more vehicles using gasoline with lower lead content the concentrations of airborne lead would be expected to decrease. However, measurements in the Los Angeles Basin between 1966 and 1975 failed to reveal any clear downward trend. This lack of trend may be the result of an increased number of vehicles and travel or it may be a consequence of the trend being so small that it is obscured by variations in the weather from year to year.

TABLE 26. MONTHLY AVERAGE LEAD PARTICLE CONCENTRATIONS AT THE RIVERSIDE MAGNOLIA AVENUE AND THE RUBIDOUX MONITORS--1975 AND 1976

	1975		1976	
Month	Magnolia Avenue ug/m^3	Rubidoux ug/m^3	Magnolia Avenue ug/m^3	Rubidoux ug/m^3
January	2.37	2.13	3.00	1.65
February	2.76	1.28	2.36	1.08
March	1.68	1.18	2.12	1.34
April	1.47	0.72	2.37	1.22
May	1.98	1.11	2.52	.83
June	1.89	1.05	2.74	1.07
July	2.41	1.26	2.12	----
August	2.42	1.61	2.08	1.18
September	2.94	2.02	2.18	1.39
October	2.71	2.86	2.90	1.37
November	3.55	1.96	4.14	2.61
December	2.93	1.56	4.52	2.94

Source: "California Air Quality Data", Quarterly Reports for 1976, Vol. VIII, California Air Resources Board, Sacramento, California.

Nitrate aerosols, mostly in the form of ammonium nitrate, comprise a significant fraction of the particulate loading in the eastern South Coast Basin. Nitrates are created through the transformation of gaseous nitrogen oxides that are emitted from motor vehicles and power plants. Intermediate steps in the process may include the formation of nitrous and nitric acid as well as organic nitrates.

Nitrogen dioxide concentrations in the industrialized Long Beach area are higher than those in Riverside. However, Riverside's concentrations of nitrates, after transport and transformation of the NO_x, exceed values along the coast. For example, concurrent measurements of nitrates along the Los Angeles Harbor Freeway and in Riverside were 4.1 $\mu g/m^3$ and 20 mg/m^3 respectively.[57]

Nitrate concentrations reach their maximum in the summer and their minimum in the winter. Near Azusa, in 1975, the average June concentration was 19.0 $\mu g/m^3$, while it was 3.5 $\mu g/m^3$ in January. However, the variation from year to year can be even greater. Between 1971 and 1975 the annual average of nitrate content in airborne particulates at this station varied from 18.4 $\mu g/m^3$ in 1972 to 3.7 $\mu g/m^3$ in 1974 and then rose back to 12.4 $\mu g/m^3$ in 1975.[58]

Unlike sulfates and the aerosols created during the daily photochemical oxidant creation process nitrates generally reach their maximum concentration in the morning.[59] This maximum accompanies the morning peak of NO_x emissions associated with traffic. Variation during the day can be quite large. A two-hour average concentration of 247 $\mu g/m^3$ was measured at a South Coast Air Basin station for which the 24-hour average that day was 19.2 $\mu g/m^3$.[60]

Most nitrate aerosols are in the submicron range. Thus they contribute to the reduction in visibility and are respirable. However, additional research is needed to determine if nitrates are actually a respiratory irritant.

It has been observed that there is a statistical correlation between high concentrations of nitrogen dioxide (NO_2) and a high incidence of cancer in urban areas; but neither NO_2 nor NO have been shown to cause cancer. It has been speculated that nitrosamines, which have been established as an animal carcinogen, may be responsible for urban cancer.[144] If this hypothesis is substantiated, there may be additional efforts to control atmospheric NO and NO_2. Under certain conditions both NO and NO_2, when combined with water, can form nitrous acid. This nitrous acid can then combine with amine to form nitrosamines. Additional study of these possibilities is required before any linkage between cancer in urban areas and the secondary products of nitrogen oxide emissions can be verified.

California has a state standard for visibility-reducing particles. It requires that visibilities be 10 miles or more when the relative humidity is less than 70 percent. With higher relative humidities, reductions in visibilities are likely to be the result of natural fogs. For instance, during the summer when photochemical smogs are most frequent in the Los Angeles Basin, the visibility reductions that occur in the morning are generally caused by the natural sea haze. As temperatures rise during the day the relative humidity decreases and the water droplets evaporate. At the same time the photochemical changes that produce oxidant and sulfate are progressing and the visibility-reducing aerosols produced by them are increasing. By midafternoon these aerosols are responsible for most of the visibility reduction.

The formation process for the visibility-inhibiting smog which accompanies the production of photochemical oxidant has been described as follows.[56]

"The aerosol-forming reactions primarily involve the oxidizing of various hydrocarbons and hydrocarbon derivatives. In this process, the first products are gases that have no effect on visibility reduction. As oxidation proceeds further, the chemical compounds formed are characterized by higher molecular weights, with the consequent lower volatilities and lesser tendencies to remain in the gaseous phase. Eventually, if the molecular weights and the concentrations are high enough, these compounds can no longer remain gaseous and they condense into tiny liquid particulates that reduce visiblity. They also act as nuclei for additional condensation that reduces visibility even further."

As opposed to coastal stations, Riverside and the other inland stations there are fewer days when the relative humidity exceeds 70 percent. Thus, poor visibilities in Riverside are seldom the consequence of a natural fog, but rather, are caused by the presence of submicron (0.1 to 1.0 pm) particulates. These submicron particles are anthropogenic in origin and arise from chemical transformations involving sulfur oxides, nitrogen oxides, and hydrocarbons.

Table 27, which presents minimum visibility measurements from one year, illustrates the variation in smog days across the basin. In summer the inland areas (Riverside and Ontario) have very few days on which there is no smog and frequently the visibility is quite poor (<3 miles). Near the coast there are more days of high relative humidity, fewer days when the State visibility standard is violated and very few days when the minimum visibility is very poor. In winter, visibility conditions at Long Beach and Ontario are comparable with about a third to a half of the days violating the standards. At Riverside during winter, the number of days with smog drop off sharply and there are some days when visibilities are outstanding (greater than 40 to 50 miles).

TABLE 27. MINIMUM VISIBILITIES AT RIVERSIDE,[a] ONTARIO,[b] AND LONG BEACH[c]

	Riverside						Ontario						Long Beach					
	Winter, 1976-77			Summer, 1977			Winter, 1976-77			Summer, 1977			Winter, 1976-77			Summer, 1977		
	Dec.	Jan.	Feb.	June	July	Aug.	Dec.	Jan.	Feb.	June	July	Aug.	Dec.	Jan.	Feb.	June	July	Aug.
Number of days when relative humidity dropped below 70%	29	27	26	30	31	30	29	27	27	30	31	29	30	28	27	27	31	29
Number of days not meeting State Standard for Visibility[d]	8	8	11	30	29	28	11	13	18	30	31	28	16	12	19	20	27	24
Number of days with R.H. <70% and visibility <3 miles	0	1	4	16	6	17	1	3	7	25	13	23	2	2	5	3	1	4
Highest minimum visibility during month (miles)	40	50	45	7	15	20	35	25	25	4	9	15	20	15	35	14	14	12
Lowest minimum visibility during month (miles)	4	2	1 1/4	1 1/4	2	1 1/2	1 1/2	2 1/2	1 1/2	1 1/4	1 1/4	1 1/2	2 1/2	1 1/2	1	2 1/2	2 1/2	2

(a) Observations made at March AFB.
(b) Observations made at Ontario International Airport.
(c) Observations taken at Long Beach Municipal Airport.
(d) State standard is visibility less than 10 miles when relative humidity is less than 70 percent.

Source: "Air Quality and Meteorology -- Monthly Reports", Southern California Air Pollution Control District, El Monte, California.

Submicron particulates are notable air pollutants both for their light-scattering potential and their ability to penetrate the respiratory system. Thus poor visibilities are an indication of possible respiratory difficulties. With a better understanding of these consequences more attention is being given to fine particles. It is probable that the Federal Government will establish ambient standards for fine particles. The cutoff size has yet to be decided since there are some deleterious effects to the respiratory system from particles as large as 15 μm.[61]

Air Pollutant Effects. Table 28 presents a list of California and Federal ambient air quality standards for comparison with examples of measurements made in Riverside for the same averaging times used in the standards. Based on the listed numbers, Riverside is clean with respect to sulfur dioxide, but has problems with the other air pollutants. However, measurements made by means of a sampling instrument are just indicators of whether the atmosphere is clean or polluted. The actual determinants represented by numbers are whether one can see mountains in the distance or cannot even see across the City. The difference between clean and polluted air is the difference between healthy, productive ornamental or farm plants versus a region where flowers or crops are damaged and agricultural yields are low. A polluted atmosphere is indicated by eye irritation, the fading of draperies, or the aggravation of bronchial problems. Air pollution episodes in some parts of the world have brought an increase of factory emissions in a valley until breathing becomes a problem and there is a noticeable increase in the death rate for several days. Riverside's pollution does not result in episodes during which the death rate increases. If there are any air pollution caused changes in the mortality rates of Riverside, they are subtle, such as a reduction of the average lifetime by a fraction of a year.

Numerical standards for ambient air quality have been set to protect against damage to health, vegetation, and materials. These standards were chosen based on the results of laboratory and field or epidemiological studies which investigated the relationship among air pollution concentrations and its damaging effects. Many of these studies were conducted in the Los Angeles Basin and at the University of California at Riverside.

TABLE 28. RIVERSIDE* AMBIENT CONCENTRATIONS OF AIR POLLUTANTS FOR RECENT YEARS IN COMPARISON WITH STATE AND NATIONAL STANDARDS

	Applicable State or Federal Standards		Recent Riverside Measurements		
Substance	Concentration	Averaging Time	Year	Concentration	Averaging Time
Oxidant (as O_3)	0.10 ppm	1-hour	1975	0.28 ppm	Highest 1-hour maximum during the year
			1975	0.084 ppm	Average of all the daily 1-hour maxima
			1975	0.031 ppm	Average of all 1-hour readings
Total Suspended Particulates	100 $\mu g/m^3$	24-hour sample	1975	467 $\mu g/m^3$	Maximum 24-hour average
	60 $\mu g/m^3$	Annual geometric mean	1975	149.0 $\mu g/m^3$	Annual geometric mean
Sulfur Dioxide	0.50 ppm	1-hour	1975	0.06 ppm	Maximum 1-hour reading
	0.03 ppm	Annual arithmetic average	1975	0.003 ppm	Annual arithmetic average
Nitrogen Dioxide	0.25 ppm	1-hour	1975	0.30 ppm	Maximum 1-hour reading
	0.05 ppm	Annual arithmetic average	1975	0.056 ppm	Annual arithmetic average
Carbon Monoxide	40.0 ppm	1-hour	1975	24.0 ppm	Maximum 1-hour reading
Lead	1.5 $\mu g/m^3$	Monthly average	1976	4.52 $\mu g/m^3$	Maximum monthly reading
			1976	2.70 $\mu g/m^3$	Annual average of monthly readings
Sulfate	25 $\mu g/m^3$	24-hour average	1974	39.3 $\mu g/m^3$	Maximum 24-hour reading
			1974	28.6 $\mu g/m^3$	Highest monthly average for the year
			1974	15.3 $\mu g/m^3$	Annual average of 24-hour readings

* All measurements except those for SO_2 were made at the Magnolia Avenue monitor. The SO_2 measurements were made in Rubidoux. Values given are the ones that were most recent and readily available for comparison with standards.

Much of the research done on the effects of oxidant has been performed in Southern California. The human symptoms of respiratory distress and eye irritation caused by photochemical smog were first observed in the Los Angeles Basin. Middleton, et al,[62] identified oxidant injury to Los Angeles vegetation in 1944. In 1961 Stephens, Darley, Taylor and Scott[63] at the University of California, Riverside, reported that the undersurface glazing and bronzing of certain sensitive leaves was caused by peroxyacetyl nitrate (PAN), a small but significant component of atmospheric oxidant.

Short-term (one to two-hour) exposures to ozone concentrations between 0.15 and 0.25 ppm may induce respiratory symptons in sensitive humans. The occurrence of these respiratory symptoms may have important health implications, especially for the developing lungs of children. While these effects appear to be reversible for healthy young adults, they may at times overwhelm the biological defense mechanisms of some persons. Laboratory experiments demonstrate that, above a minimal ozone exposure level, the joint presence of ozone and sulfur dioxide affects lung function as though the entire dose was ozone.[64] A high proportion (about 5 percent) of Los Angeles residents reports difficulty in breathing during smog episodes. Respiratory difficulties are also more prevalent in Los Angeles, regardless of episode conditions. Among outside telephone workers in the age group of 50 to 59, a significant excess of persons with coughs was observed among Los Angeles residents when compared with those in San Francisco and other United States cities.[65] These differences could not be explained by social class, occupation or smoking habits.

There is no evidence for an increased risk of mortality in association with the daily oxidant concentrations measured in the Los Angeles Basin. It has been found that the increase in deaths which accompanies oxidant episodes results from the higher temperatures present during those periods and not from the oxidant. One illustration of this cause-effect relationship is the two community study conducted by Landau et al.[66] They divided the area of Los Angeles County, California into regions that had similar autumn temperatures, but differing oxidant concentrations and then examined records to see whether there was any difference in daily mortality attributable to the differences in oxidant concentrations. None was found.

While eye irritation may be the most frequent complaint during Southern California oxidant episodes, ozone, which is the principal component of the oxidant, is not the eye irritant. Eye irritation appears to be a summed effect of a number of organic products in the smoggy air. These include formaldehyde, acrolein, and peroxyacyl nitrates. Formaldehyde and acrolein, while they are products of the photochemical process, are not oxidants. Additionally, particulate matter in either relatively pure air or oxidant-laden air may cause a person to squint becuase of the high reflectance and scattering of sunlight and the consequent production of glare. The person may relate this squinting to eye irritation. The tearing or burning of eyes does not begin until oxidant concentrations reach 0.30 ppm. Concentrations of this magnitude are infrequent outside of Southern California and this probably explains why eye irritation does not occur in the ambient atmosphere of cities outside of this region.[67]

With regard to vegetation, two components of oxidant smog have been identified as phytotoxicants. Ozone makes the upper surface of leaves appear splotched or stippled. If the concretation is high enough, holes may develop in the leaves. The other oxidant that damages plants is peroxyacetyl nitrate (PAN), which can make the underside of leaves of susceptible plants -- citrus trees in particular -- turn silver or bronze. Apparently PAN is a phytotoxicant for which the effects have been rarely observed outside California.[68]

Decreased growth and possible reductions in yield and productivity have been reported from mixtures of ozone and sulfur dioxide.[69] Optimal conditions for plant growth increase the sensitivity of plants to ozone. Drought during growth increases the resistance of plants to ozone damage.

Erosion of materials, such as auto and industrial paints has been observed to occur at a greater rate in Los Angeles than in parts of the country which have clean air. By considering the composition of these paints and their reactivity to various air pollutants it was deduced that the increased damage to these types of paints resulted from the higher ozone concentrations in Los Angeles.[70] Losses from air pollutant damage can be of two types -- costs to replace the damaged item and costs to prevent damage to the item.

Carbon monoxide effects on human health far outweigh any CO effects on vegetation and materials. Automobile exhaust is the chief source of ambient CO and maximum ambient concentrations occur near streets and freeways. However, smoking is a much greater contributor than auto exhaust to increased levels of carboxyhemoglobin in the blood -- the direct measure of CO dosage. The greater the amount of CO intake, the higher the level of carboxyhemoglobin in the blood. As carboxyhemoglobin levels increase, the capacity of the blood to carry oxygen decreases. When air quality standards were first set in California in 1959 the effects of carbon monoxide on the limitation of oxygen transport were a guiding criterion. Among the persons to be specially protected were those with heart disease. During acute attacks the heart needs an increased supply of oxygen. Although some human organs can increase their oxygen supply by increasing the oxygen amount they extract from the blood the heart can only get more oxygen through an increased flow of blood. Persons with heart disease have rigid blood vessels supplying their hearts, therefore, an increase in circulation is difficult. Consequently, it is beneficial for their blood to contain a maximum amount of oxygen. Because of their high mobility, urban residents are exposed to a wide range of carbon monoxcide concentrations during a day. Numerous studies of CO levels in automobile traffic have been conducted and there is a dearth of reliable epidemiologic data on the health effects of chronic carbon monoxide exposure. Deane[(71)] found that Los Angeles drivers had an increase in carboxyhemoglobin during the morning commuting period. Aronow et al[(72)] found that angina pectoris patients who rode around the streets and freeways of Los Angeles for 90 minutes were exposed to air containing approximately 50 ppm of CO. Two hours after the trip the patients were still experiencing a decrease in their exercise capacity.

Nitrogen dioxide is the nitrogen oxide that can directly affect health; however, the long-term ambient concentrations are considerably below the concentrations that have been found to be detrimental to human health. Remmers and Balchum,[(73)] in a study of oxidant effects, found no significant effect of nitrogen dioxide on airway resistance in persons with chronic respiratory disease. It appears that more information on the impact of nitrogen oxides on health will have to come from the nitrosamines studies. Taylor has noted that the short-term NO_2 concentrations that cause vegetation damage are on the order of 5 to 20 ppm, but NO_2 is decomposed photochemically and therefore, concentrations this high are never observed in the ambient air. Long-term exposure to lower concentrations may inhibit growth without producing visible damage. However, even these concentrations are higher than ambient average levels. Taylor and Eaton[74] observed a decrease in the weight of pinto beans (in NO_2 concentrations of 0.3 ppm) and in the weight of tomatoes (in NO_2 concentrations between 0.15 and 0.26 ppm) after exposures of 10 to 19 days. Thompson, et al.,[75] found that naval oranges had increased amounts of lead drop and decreased yields when exposed to NO_2 concentrations of 0.25 ppm for 8 months. Ethylene, a major product of auto exhaust is more than 50 times as phytotoxic to vegetation as are other hydrocarbon gases. It causes damage to cotton, tomatoes, orchid blossoms, as well as reducing plant yield.[76]

Many health studies have considered the effects of particulates and sulfur oxides or particulates and sulfates concurrently. This approach is used because, in general, these pollutants come from the same source -- the combustion of fossil fuels -- and because their concentrations have been very high in areas where acute episodes have occurred. Some health studies have tried to determine the amount of damage which can be attributed to each of these pollutants when they occur in combination. While the episodes, such as those in London in 1952 and 1962, and Donora, Pennsylvania, in 1948 have given clear evidence of the mortality that accompanies high concentrations of sulfur oxides and particulates, it is much more difficult to demonstrate mortality as a consequence of long-term exposure to low levels of these pollutants. In fact, it is probable that sulfur oxides alone at the concentrations generally observed are not especially hazardous to health unless they are oxidized into sulfate aerosols. Lave and Seskin,[77] studying death rates in 117 metropolitan areas of the United States, believe that concentrations of particulates and sulfates are significant factors in explaining mortality. However, their conclusions can be questioned on the basis that they used monitoring data from only one site in each city.[78]

There is general consensus that concentrations of SO_X and particulates which exceed the ambient annual standards will be accompanied by:

(1) increased susceptibility to acute lower respiratory infections

(2) aggravation of chronic respiratory disease, such as bronchitis or asthma and

(3) decreased lung function.

Materials breakage of the nickel-brass wire springs in some relays in Los Angeles was discovered by the Pacific Telephone and Telegraph Company. It was later shown that the failures were produced by nitrates in the dust which had accumulated on surfaces adjacent to the cracked areas.[79] Upon further investigation it was learned that the nitrate content of the Los Angeles dust was 5 to 10 times greater than that of dust in eastern or mid-western cities and that the Los Angeles dust was more reactive to moisture. Failures in the relays were observed when nitrate depositions exceeded 2.4 $\mu g/cm^2$ and the relative humidity was greater than 50 percent. Levels of nitrogen dioxide which exist in urban areas produce visible fading in a number of fabrics. High relative humidity and high temperature contribute to the fading.

Hydrocarbon compounds of greatest importance in air pollution fall into two groups, olefins or ethylene series, and aromatics or benzene series. Few studies have looked at the direct effect of olefins on human health. Generally, olefin emissions are considered in their role as a precursor for photochemical oxidants.

Aromatic hydrocarbons can be produced by any combustion process involving hydrocarbons, but the emissions are greater from inefficient combustion. Among the aromatics there are a number of compounds which are believed or known to be carcinogenic. The most potent of these is benzo [a] pyrene, abbreviated BaP. Taking cigarette smoking into account as a major factor in lung cancer, there is an additional urban factor that appears in epidemiological studies. One suggestion has been that the concentration of BaP is a significant indicator of this urban factor. However, there is also evidence that the relationship between lung cancer death rates and BaP concentrations in urban areas is not as pronounced as that between lung cancer death rates and sulfate concentrations.[80]

Annual average ambient concentrations that accompanied some of these investigations ranged from 85 to 250 ug/m^3 for particulates and from 0.01 to .16 ppm for sulfur oxides. Many investigators concluded that particulates were a more significant factor than were sulfur oxides. There has been little research on the effects of mixtures of settleable particulates from a specific source, such as cement dust from Portland cement plants. Another class of aerosols receiving considerable study are the sulfuric and nitric acid aerosols which produce acid rain. The effects of acid rain on vegetation include leaf necrosis and the creation of excessive acid levels in the soil. While low ambient concentrations of sulfur dioxide can stimulate growth in some plants, high concentrations can cause chlorosis in older leaves. Two plants sensitive to SO_2 are cotton and alfalfa. Generally, material damage by particulates also involves other air pollutants. Airborne particles can act as nuclei for adsorbed or absorbed gases and gases can form aerosols. Masonry and concrete can be discolored or eroded by the combination of particulates and sulfuric acid. The combination of particulates with sulfur oxides or ozone can cause paints, enamels, and finishes to be discolored or lose their glossy appearance. Particulate matter in the atmosphere soils fabrics but does not damage them. Economic loss occurs from the costs of cleaning and the eventual deterioration of the fabric resulting from repeated cleanings. As mentioned in the particulate discussion of material effects, the impact of sulfur oxides is caused by a combination of particulates with the acids created by the combination of SO_2 and SO_3 with moisture in the air. These acidic gases can react with limestone to produce a slow erosion of building surfaces. Paints exposed to 1 to 2 ppm of SO_2 require 50 to 100 percent more drying time.

Energy Conservation Education in the Riverside Community

Energy education programs can range from those that impart general information about the energy problem to those that impart very specific information. Programs at the "general information" end of the continuum frequently emphasize the fact that there is an energy problem, why there is an energy problem, and, in general, what we need to do to solve the problem. These general information programs, if done well, have some usefulness in that they may serve to change individual and group attitudes over a period of time. They may also help to prepare people for other types of conservation programs, such as incentive programs or allocation schemes. When utilized as part of a school curriculum they help to shape or develop conservation attitudes in young people. Irrespective of their audience, these general education/information programs may be considered "persuasion" programs if their goal is to bring people to a change in their lifestyle or in their consumption patterns.

Programs at the "specific information" end of the continuum are usually directed toward an individual or select group of individuals such as homeowners, drivers, etc. These programs usually relate to providing specific information about specific solutions to specific areas of energy waste. It is assumed that there is a specific need that members of these groups have and that there are specific benefits or "subjective utilities" that members of these groups will realize if they follow a particular course of action. For example, a program may inform a homeowner of the subjective utility (i.e., dollar savings) associated with insulating his home. Or a program may supply the homeowner with "feedback" on his rate of consumption and indicate the amount of money which could be saved by varying degrees of conservation.

Many energy education programs are a combination of these two types of programs or fall somewhere on the continuum between programs that are intended to change attitudes and programs that are intended to provide solutions to specific needs.

The energy education programs currently being planned for or implemented in the Riverside Community area include the following:

(1) City of Riverside Public Utilities Department. The City of Riverside Public Utilities Department serves approximately 57,300 customers. The department distributes energy purchased largely from Southern California Edison. Customers are 91.8 percent residential, 7.6 percent commercial, 0.3 percent industrial, and 0.3 percent other. The electrical peak load occurs in the summer and is caused mostly by residential air conditioning. Since the summer peak averages 50 to 60 percent higher than the winter peak load, the Public Utilities Department has selected residential air conditioning as the most important consideration in any conservation effort. As part of their UCAN Action Plan[81], the Riverside Public Utilities Department has proposed several activities. The following are most relevant to community education and information in the area of energy conservation and efficiency measures.

- Dealer Support Programs:
  - Manufacturers of highly energy efficient products would be contacted to obtain information and advertising materials.
  - An information file would be maintained on highly energy-efficient products for customer handout.
  - A home economist would be available for store and home demonstrations of products and conservation programs.
  - Mailers and bill stuffers would be used to encourage customer acceptance of new energy efficient products.
- Customer Education Programs: These programs would consist of the following - utilization of bill stuffers, handouts, and dealer ads, as well as field contacts by power service personnel. Subjects would be:
  - Load management devices
  - Heat pumps
  - Demand metering and rate application
  - Energy savings through end-use efficiency
  - Nuclear generation
  - Home economics (insulation, kitchen planning, etc.)

Proposed programs in the "load management" area which are relevant to energy education and information would include:

- Energy Audits
  - A comparative month-by-month study of demand and kwhr consumption of customers who use 150 kwhr or more--to be used for customer information on energy conservation.
  - Field visits with the customer's Plant Maintenance and Plant Engineering Personnel to aid them in energy conservation.
  - Energy efficiency awards.
- Deferred Demand
  - A file kept on current demand limiting devices for customer handout and advice.
- Load Management
  - Contacts with large users would be intensified to encourage the reduction of peaks, including an evaluation of the applicability of time-of-day rates.
- Conservation
  - Better insulation in existing homes would be encouraged through direct marketing and by counselling on tax incentives and benefits.
  - Increased contacts with large industrial and commercial users to conserve on lighting and air conditioning.
  - Continued talks and demonstrations to directly provide information, service and marketing of conservation devices to individuals in their homes.
  - A continued information program and a program to reduce use of water, especially hot water, in the home.

There are other aspects of this proposed program which are not referenced here because they are not directly relevant to the information/education area. It should be noted, however, that because of the limited staff and budget restrictions, the Riverside Public Utilities Department may not be able to initiate new programs. The Riverside Public Utilities Department has instituted a consulting service for business and industry. This is a one-to-one approach that utilizes a "walk thru program", frequently in response to requests. The program provides advice on load management. A limited advisory service has also been implemented in the residential sector.

Brochures (advertisements, conservation and public relations material, etc.) directed to the residential consumer are available from Southern California Edison. However, the City Utilities Department wants to maintain its separate identity, and the Edison materials have the Edison logo and/or advertisement on them. On the other hand, Edison does not want to print and give away material that does not contain their logo. Therefore, the City has not distributed Edison conservation materials.

(2) Southern California Edison Company. Programs offered by the Southern California Edison Company could be applicable to the City of Riverside since these programs are directed toward the Southern California region and since the Riverside Public Utilities Department purchases power from Southern California Edison. Southern California Edison's February, 1977, rate adjustment application before the Public Utilities Commission (PUC) of the State of California (Application No. 57111)[82] sets forth several energy conservation programs that involve public education or information exchange. These programs are reiterated in Southern California Edison's Conservation Report for the California Public Utilities Commission, March 31, 1977[83].

In a letter dated December 19, 1975, the President of the Commission requested Southern California Edison to expand their conservation efforts and stated the Commission's intention as:

> "The PUC will expect utilities to develop a sophisticated analytic capability to evaluate conservation measures which may go beyond the conventional scope of utility activities, to make aggressive use of their marketing capabilities to educate the public in conservation and, where reliable and cost-effective, to promote energy-saving design and technological changes."

Application No. 57111 (February, 1977) describes three levels of conservation programs. These are:

- Level I - ongoing conservation programs as reflected in Application No. 54946.

- Level II - additional conservation programs submitted in connection with General Rate Applications No. 54946.
- Level III - supplemental conservation programs, the cost of which Edison seeks to recover through offset rate relief.

Programs listed under these three levels, which fall within the area of public education and information, are described in detail in Appendix G and by title only in the following:

Level I

a. Consumer Education Program
b. Advertising Program

Level II

a. Sure Actions for Valuable Energy Savings (SAVES) Program
b. Solar Water Heating Demonstration/Publicity Program
c. Electric Water Heating Conservation Program
d. Energy Conservation Kit for New Customers
e. Expanded Information/Publicity Programs

Level III

a. Energy Mart
b. "Hy Efficiency"
c. "Sherlock Homes Program"
d. Commercial and Industrial New Customer Kit
e. "Lumen Lesson"
f. Public Awareness Program

Increased public awareness would be accomplished through a multi-faceted program that would have the following components:

- Conservation services by a pool of skilled personnel to provide support to staff and line organizations in planning events, conducting field surveys, coordinating meetings, and assisting other departments.

- Educational support services in the form of programs and teaching materials.
- Exhibits and displays
- Public and employee communications
- Speakers bureau
- Speech and educational materials such as brochures, pamphlets, bill stuffers, slides, tapes, and film strips.
- Workshops, seminars and forums
  - Architect, engineer, and design consultant forums
  - Community leader forums
- Dealer/contractor heat pump seminars
- Electrical maintenance seminars
- Plant engineers workshops
- P.I.P.E. Institute to assist the Plumbing Industry Progress and Education Institute with solar energy and end-use applications.
- Specifier workshops
- Lighting workshops

g. "Give Your Appliance the Afternoon Off"
h. Conservation and Load Management for Resale Customers

(3) Southern California Gas Company. The Southern California Gas Company markets directly to individual customers in the City of Riverside. A listing by title of some of their energy conservation programs which incorporate an education or information aspect include: (See Appendix G for more detail).

a. Insulation Program
b. Consulting Service to Industry
c. Advertising Program
d. Direct Sales Program
e. Conservation Hot Line
f. Consumer Information Program
g. Conservation Centers Program
h. Insulation Program for Existing Homes

(4) People's Energy Fair. A people's energy fair was held on October 1, 1977 at the Riverside downtown mall. The energy fair was organized by Representative George Brown's Office. The main objective of the fair was to bring people together to exchange ideas and discuss energy conservation programs that had been implemented locally. This appears to be a concept of merit in increasing awareness and providing for information exchange.

(5) Media. Riverside local media includes two major newspapers, the Press-Enterprise, and a number of smaller publications. Included among the smaller publications are the Riverside Community News and a number of newsletters. A good example of the newsletter type of media is the Pollution Crier, published by the Pollution Control Research Institute. While all of these sources occasionally publish informational articles on energy conservation, there does not appear to be any directed, long term energy information program that they adhere to.

Also included among local media are four radio stations. Riverside does not have its own TV station. The City receives TV transmission from Los Angeles stations and is therefore somewhat limited in the use of the TV medium, since energy information presented via TV would generally have to be national or regional in scope, rather than local.

(6) Educational Institutions. One major asset of the City of Riverside is a number of universities/colleges. The principal resource among these is the University of California at Riverside. UCR is a potential source of expertise which can be employed in many community information/ education programs. UCR also offers a variety of courses, such as solar energy classes, which include conservation measures. The availability of courses of this type is important to the community, in spite of the limited appeal that they are likely to have. For example, the UCR Physics Department and the Extension Service cooperated in organizing an international conference "Toward a Model Energy Community", which was held in Palm Springs in April, 1978.

Other institutions of higher education in the Riverside community include: La Sierra campus of Loma Linda University, California Baptist College and Riverside City College (a 2-year community college). It is conceivable that all of these institutions would have some faculty members who could serve as a source of expertise to the community in the area of energy education.

Additionally, the City of Riverside is served by two public school systems: (1) Riverside Unified School District, and (2) Alvord School District. These include 31 elementary schools, 7 intermediate schools, and 6 high schools. The Jurupa School District serves some adjacent, non-incorporated areas.

The Riverside Unified School District has been providing some energy related instruction for approximately 2 years. Instructional materials on energy are obtained primarily from companies specializing in energy production, distribution, or related equipment. These materials, provided by the companies, are combined into a curriculum package that is made available to each school. There is no prescription regarding specific grade levels at which these materials should be used, however. In fact, since they are not part of the required curriculum, there is no guarantee that all students are exposed to energy information as part of their academic program. In grades K through 8, which have one primary teacher, the energy information would probably be tied to science and/or social studies subject areas. In grades 9 through 12, energy education would be most applicable to social studies or science classes.

One possible problem with the utilization of curricular materials provided by utilities/industry is a California law that requires school districts to screen such materials to assure that a particular company is not getting favored treatment or publicity via the curricular materials that they have provided. This law is intended to prevent the use of the school systems as a means of "proselytization". Of course, if their names cannot be used, the energy companies have less motivation for developing and donating materials.

It was the judgment of school district personnel that they have not seen a good, integrated energy curriculum for grades K through 12. The natural gas utility has provided some materials that have applicability for use at the K through 12 grade levels, however. As stated previously, these materials, if used, would be employed at the discretion of each teacher.

The Alvord School District has received some energy-related materials from the regional electric utility and has obtained some commercial film strip materials. These materials are available to interested teachers. There is no specification regarding grade levels at which these materials should be used; however, they are probably most appropriate for grades 6, 7 and 8. If utilized, it would be as part of science or social studies curricula. There apparently is no in-depth instruction relative to energy at any of the K through 12 grade levels, however.

The Jurupa School District, which serves some nonincorporated areas adjacent to Riverside, does not have any formal energy education curriculum or materials. Some of the science or social studies teachers may reference the energy topic of their own accord.

(7) Libraries. There are six public libraries in Riverside. These could serve as a focal point for energy conservation information through use of books and literature, through the sponsorship of special programs, and through utilization of library facilities by interested groups.

(8) Industrial Programs. One potential means of implementing an energy conservation information program is within the work environment. The Riverside community area contains a number of moderate size manufacturers. The largest among these, with their approximate employment, are:

Fleetwood Enterprises	1,450
Bourns Incorporated	1,076
Rohr Industries, Inc.	1,040
Riverside Cement Co.	599
Owens-Illinois/Lily Div.	420
Alumax Mill Products	418
Toro Company	350

Rohr Industries, Inc., typifies an industry that has an active energy conservation program. Their program has concentrated on in-house energy conservation, but has also provided information applicable to employee residences. Rohr has established an energy conservation committee that includes 20 hourly employees. This committee, which meets on a monthly basis, provides a link between management and employees. One information technique utilized at Rohr has been to post the monthly energy use as means of supplying feedback on the effectiveness of energy conservation measures.

Large nonmanufacturing employers in the Riverside area, with their approximate employment, include:

County of Riverside	3,977
University of California, Riverside	3,600
Riverside Unif. School District	2,368
City of Riverside	1,449
March AFB (nonmilitary empl.)	1,300
Alvord Unif. School District	850
Pacific Telephone Company	800
Riverside Community Hospital	787
E.L. Yeager Construction	500

These employers could also supply an excellent environment for energy conservation education.

(9) Other Applicable Energy Education Programs. Other applicable energy education programs of probable interest to Riverside exist in California and throughout the country. Details of a number of these are given in Appendix G.

BUSINESS-AS-USUAL PROJECTIONS

Population Growth

The current population of Riverside is approximately 163,000. The exact figure is not available, although each of the interested parties within Riverside and the State of California have made their own projections. Figure 24 presents six population estimates and two projections to the year 1990.(84-88)

Three population growth scenarios were developed from which projected energy demand profiles will be derived. Assumptions are that population growth is the fundamental determinant of energy demand, and that the appropriate starting point for evaluating the impacts of various levels of conservation efforts is projected population coupled with no new conservation programs, or a "business-as-usual" situation.

The three projections of average annual population growth are based upon recent historical trends, current developments in growth management policies, and the probable course of future residential activity in the context of available developable land.

Recent Demographic Trends

Between 1950 and 1976, population in Riverside increased from 46,339 to 163,000, or a 250 percent over the 26-year period (Table 29). Although consistently high throughout the 26-year period, average annual growth rates have declined from 6.08 percent, during the fifties to 2.57 percent between 1970 and 1976. During the same 26-year period, the city land area increased from 39.20 square miles to 71.57 square miles, or 83 percent. No significant territorial expansion has occurred since 1964, when the La Sierra area was annexed. This area, together with the University community annexed in 1961 and the Arlanza area annexed in 1962, added a total of 29,000 to Riverside's population during the 1960's. This represented approximately half of the population growth of 57,000 experience during the 1960's. In contrast to annexation, the post-1970 population increase is attributed largely to in-migration from areas west of the City, namely, from Orange County.

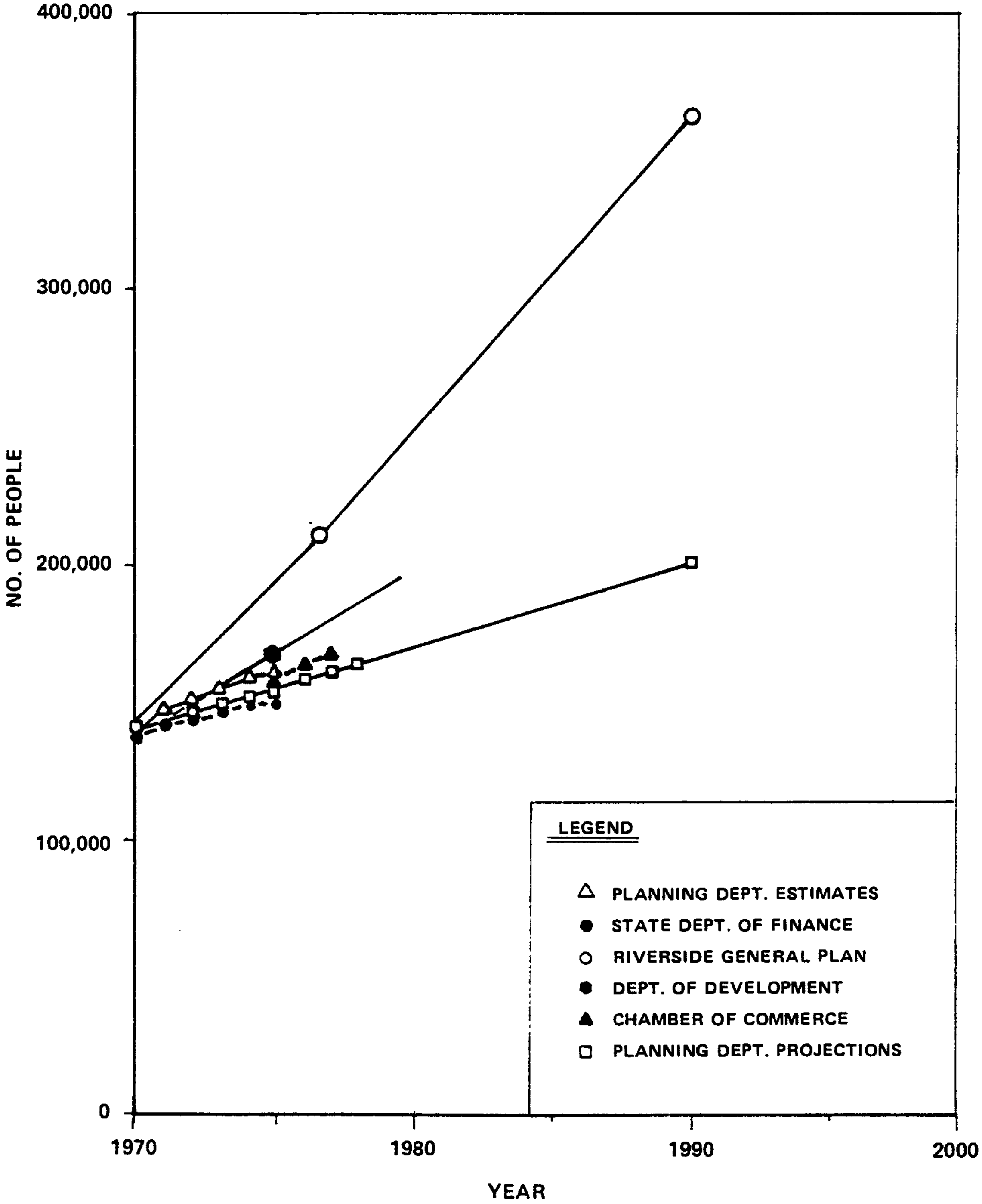

FIGURE 24. ANNUAL POPULATION GROWTH AND PROJECTIONS

TABLE 29. POPULATION AND AREA OF THE CITY OF RIVERSIDE*

Year	Population	Area, square miles	Average Annual Growth Rate, ercent
1976	163,000	71.57	
1975	158,000	71.33	
1974	155,000	71.33	2.57
1973	152,000	71.82	
1972	146,000	71.57	
1971	143,000	71.54	
1970	140,000	71.52	5.28
1960	83,714	43.59	
1950	46,399	39.20	6.08

* Sources: 1950 and 1960 populations and area figures from Riverside Planning Department.

1970-1976 population from the Riverside Chamber of Commerce.

At the present time, intense developmental pressures persist in Riverside. The City has become an attractive residential alternative to Orange County, where housing costs have dramatically increased during the last decade. Demands for new manufacturing, assembly, warehousing and distribution building space have made additional large-scale residential development increasingly difficult in Orange County. These business developments have induced prospective home owners--who represent a growing proportion of all households--to seek alternatives in the relatively inexpensive areas of Riverside City and County.

The outcome of the land development pressures in recent years has been a record number of additions to the Riverside housing stock. In the 1970 to 1975 period, according to Planning Department figures, total dwelling units increased from 45,928 to 53,900, or 3.3 percent annually. During the same period, population increased only 2.6 percent. The building boom culminated in the months immediately preceding the imposition of a moratorium on new building permits, which took effect November 25, 1977. In October and November of that year, according to the Riverside Press-Enterprise, Riverside issued permits for 3,463 residential units, or more than three times the combined total of permits for Anaheim, Santa Ana, Pomona, San Bernardino, and Los Angeles City.(89) This partly resulted from builders' efforts to escape the moratorium; nevertheless, the order of magnitude reflects the magnitude of residential development pressures experienced by the City for the past half decade.

Birth/Death and Migration Rates to the Year 2000

Population change in Riverside through the year 2000 will depend upon trends in birth/death rates (natural increase) and migration rates. In general, it is safe to assume that migration patterns will continue to act as the dominant variable in Riverside's demographic change. During the 1960's, natural increase accounted for only 25 percent of the total population increase of approximately 57,000. The remaining 75 percent, or 43,000 was attributable to net in-migration, most of which occurred during the 1965 to 1970 period. Furthermore, migration rates are a far less predictable component of population change than are birth and death rates. No drastic adjustments in either are likely to occur within the 22-year time horizon of the present study.

Future trends in migration in Riverside are dependent upon a number or socioeconomic and institutional developments. First, the attractiveness of Riverside as a residential alternative to Orange County is contingent upon the comparative housing cost in the two communities. The present gap in housing costs is likely to diminish over time as Riverside's housing prices continue to escalate and the present nonresidential land development pressures -- and price increases -- in Orange County peak out within the next decade. As these trends evolve, we may expect that the home buyers[90] will seek relatively low-cost properties in unincorporated Riverside County and other smaller municipalities south and west of the City.

Second, undeveloped land zoned for residential use is limited to approximately 10,800 acres.[91] Numerous development alternatives (discussed below) currently are being examined by the City to determine the preferred mix of new development versus preservation of agricultural lands. Whatever the alternative selected, population growth will be constrained by the territorial limitations of the City, now totaling 71.57 square miles, of which approximately 50 percent is developed for residential, commercial, and industrial use.[91] Future annexation of substantial proportions is an unlikely event in view of existing life-style differences between the City and unincorporated area.

Third, and most crucially, the specific content of the City's evolving growth management program will play a key role in determining future population levels. Since the narrow defeat of the growth control initiative in October, 1977, and the subsequent imposition of a moratorium on residential building permits on November 25, 1977, the City Government has considered a number of options for managing future residential development in Arlington Heights. This area consists of 12,300 acres (two-thirds of which are located within the municipal limits) and represents the largest continuous undeveloped area in Riverside. Options ranging from a maximum population of 28,650 to that of 58,869 have been considered;[27] the 111,795 population level permitted under the City's General Plan has been dismissed as a serious candidate for future consideration.

As of May 1, 1978, the Riverside Planning Department had prepared, in draft form, an ordinance based upon a points system for evaluating the City's capacity to adequately service new housing developments. Although the Arlington Heights/citrus grove controversy (see Community Design section) the October initiative and the permit moratorium were the major immediate inpetuses behind this ordinance, it was drafted to create a permanent mechanism for assessing the desirability of new housing developments throughout the City. Included in the point system are service level standards for each of the following services: drainage, electricity, fire, parks, schools, sewers, streets, and water. Developments that do not meet a minimum number of points will not be issued building permits. If implemented, the tentative plan would permit approximately 35,000 new residents in the Arlington Heights area under current zoning regulations; however, only about 20,000 of these new residents would reside within the City limits.(92) The cooperation of the County Government is, of course, prerequisite to the complete implementation of the proposed plan.

Three Futures

On the basis of the preceding discussion, three population growth scenarios were derived to project Riverside's population through the year 2000. These three average annual percentage growth rates, representing high, middle, and low projections are used to construct baseline energy demand profiles, assuming no new conservation efforts are implemented.

In contrast to the usual macrolevel projections that assume no spatial constraints on population growth, the microlevel approach adopted herein explicitly incorporates territorial limitations as a major determinant of population change. Assumptions were: (1) that the current municipal limits will remain essentially unchanged through the year 2000, i.e., no major annexations; and (2) that the availability and development densities of vacant land will act as the primary control on population growth. In later appendices, such as those dealing with policy options and outcomes, these assumptions are relaxed.

Scenario 1: High Growth

Assumptions:

(1) In-migration of home buyers from Orange County continues to exert intense pressures on undeveloped land in Riverside.

(2) Birth/death rates remain approximately at 1978 levels.

(3) A growth management ordinance permits a total of 20,000 new residents in the Riverside portions of Arlington Heights, or approximately 15,710 new residents by the year 2000.(93)

(4) Three-fourths of the 11,172 acres of vacant land is developed with a housing mix characteristic of the City as a whole, amounting to 11.25 persons per residentially developed acre.(91)

Population Growth-Rate Calculation, 1976 to 2000:

Additional Population in Arlington Heights	15,710
Additional Population in Existing Vacant Land Converted to Residential Use	94,264
Total Additional Population	109,974
1976 Population	163,000
Total Population in Year 2000	272,973

Average Annual Rate of Growth 1976 to 2000 is 2.17 Percent.

Scenario 2: Low Growth

Assumptions:

(1) In-migration of home buyers from Orange County diminishes rapidly as Riverside housing costs escalate and become uncompetitive with alternative residential locations.

(2) Birth/death rates remain approximately at 1978 levels.

(3) A growth management ordinance permits an additional 15,710 new residents in Arlington Heights; however, rapid deflation of housing markets attributable to (1) above results in only 50 percent of that limit by the year 2000.

(4) One-quarter of the 11, 172 acres of vacant land is developed with a housing mix characteristic of the City as a whole, amounting to 11.25 persons per residentially developed acre.

(5) No major annexations occur.

Population Growth-Rate Calculation, 1976 to 2000:

Additional Population in Arlington Heights	
.5 x 15,710 =	7,855
Additional Population in Existing Vacant	
Land Converted to Residential Use	
(.25 x 11,172) x 11.25	31,421
Total Additional Population	39,276
1976 Population	163,000
Total Population in Year 2000	202,276

Average Annual Rate of Growth 1976 to 2000 is 0.90 Percent.

Scenario 3: Middle Growth

Year 2000 Population	233,009

Average Annual Rate of Growth is 1.55 Percent.

This is the average of the high and low growth rate scenarios and represents the most probable scenario. It approaches the RPD's projected growth rate of 1.8 percent and is consistent with the recent trend toward lower forecasts for Riverside as well as other Southern California cities.(94) This projection implicitly assumes: (1) continued, through relatively modest, development pressures created by in-migration from Orange County; (2) a growth management program under which the Arlington Heights population approaches its permitted level; and (3) the conversion of approximately half of existing vacant land into residential use, continuing the current city-wide housing mix.

Table 30 summarizes the year 2000 population levels for each scenario and the respective average annual growth rate for each.

TABLE 30. THREE POPULATION GROWTH SCENARIOS: 1976-2000

Scenario	Year 2000 Population	Average Annual Growth, percent
High	272,973	2.17
Middle	233,009	1.55
Low	202,276	.90

Stationary Energy Demand Projections

Electrical Energy Projections

Figure 25 presents the historical growth and projections of electrical energy requirements for three population scenarios. Electrical energy here encompasses all of that used for: lighting, power, and space cooling. The projections represent the total requirements of all of the consuming sectors in Riverside. The distribution of the required energy to each of the consuming sectors is presented below.

Table 31 shows the percentage of total annual electrical energy that will be required by each sector, for each of the two end uses: space cooling (the weather sensitive component of electrical energy), and base load (the weather-independent component of electrical energy. The line losses listed in the table account for the energy lost in transporting electricity to the consumers within Riverside; these losses have been considered separately from the actual requirements of the consumers. The relative percentage of energy distributed to each consuming sector is expected to remain fixed throughout the entire time-frame projection.

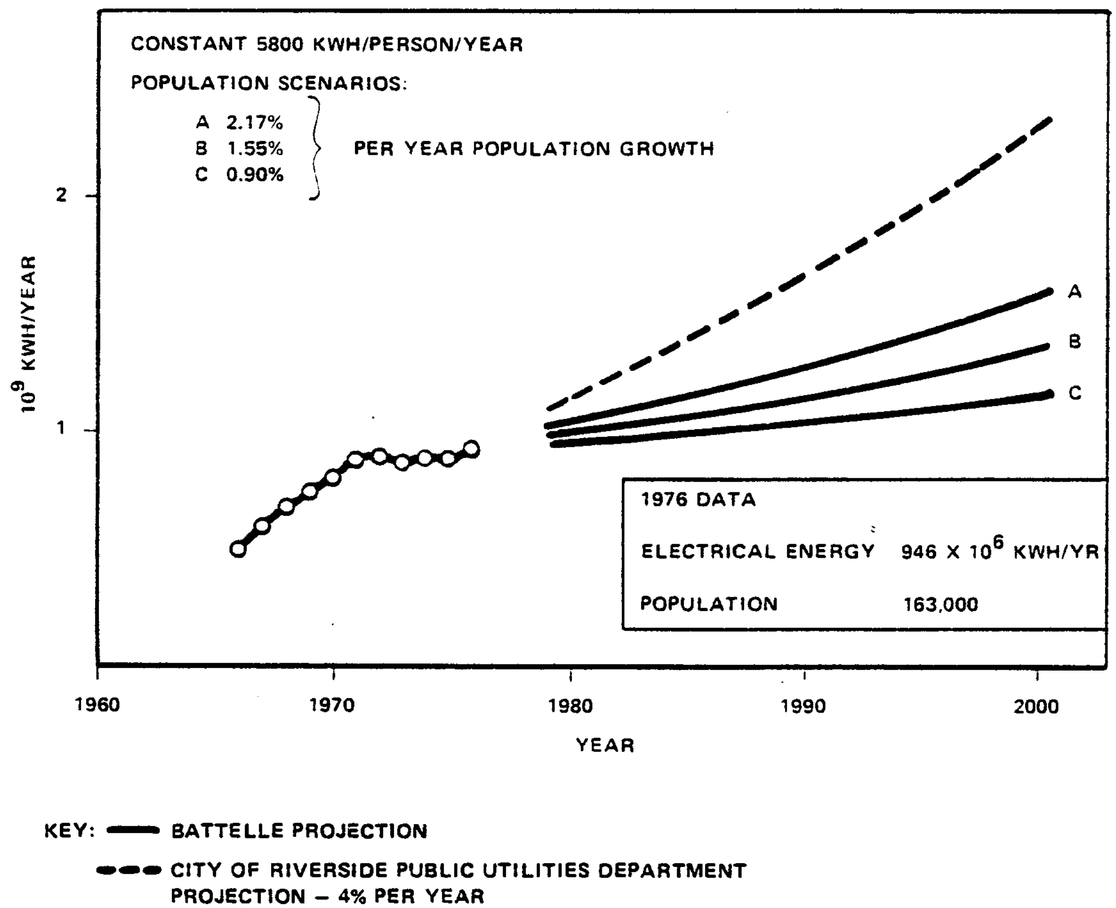

FIGURE 25. GROWTH AND PROJECTIONS FOR ELECTRICAL ENERGY

TABLE 31. ELECTRICAL ENERGY DISTRIBUTION

Percentage of Annual Requirements

	Space Cooling	Base Load	Total for Sector
Residential	7.8	26.2	34.0
Industrial	1.2	11.1	12.3
Commercial	4.7	38.9	43.6
Total for End Use	13.7	76.2	89.9
Line Losses	--	--	5.5
Other	--	--	4.6
			100.0

Figure 26 presents the historical growth and projections of peak summer electrical energy demand.

Thermal Energy Projections

Figure 27 presents the historical growth and projections of thermal energy requirements for three population scenarios. Therman energy encompasses all of that energy used for: space heating, water heating, process heat, cooking, etc. (Uses requiring temperatures have ambient conditions). The projections represent the total requirements of all of the consuming sectors in Riverside. The distribution of the required energy to each of the consuming sectors is presented below.

Table 32 contains the percent of total annual thermal energy that will be required by each sector for each of the two end uses. The relative percentage of energy distributed to each consuming sector is expected to remain fixed throughout the entire time-frame projection.

TABLE 32. THERMAL ENERGY DISTRIBUTION

Percentage of Annual Requirements

	Space Heating	Base Load	Total for Sector
Residential	15.7	36.2	51.9
Industrial	2.0	19.7	21.7
Commercial	5.7	19.7	25.4
Total for End Use	23.4	75.6	99.0
Other	--	--	1.0
			100.0

Transportation Fuel Use Projections

Table 33 shows the project vehicular fuel use for Riverside for the three projected population growth assumptions. For comparison purposes the estimated 1976 consumption is also shown.

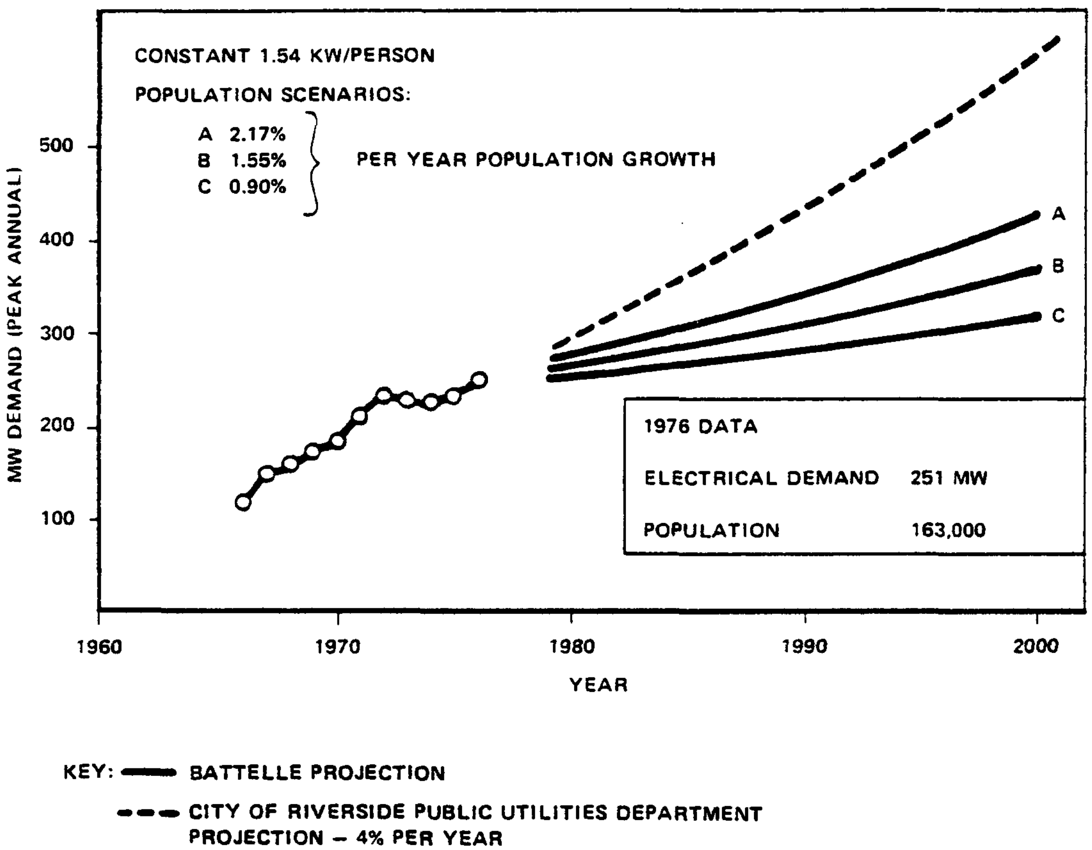

FIGURE 26. HISTORICAL GROWTH AND PROJECTIONS FOR PEAK ELECTRICAL ENERGY DEMAND

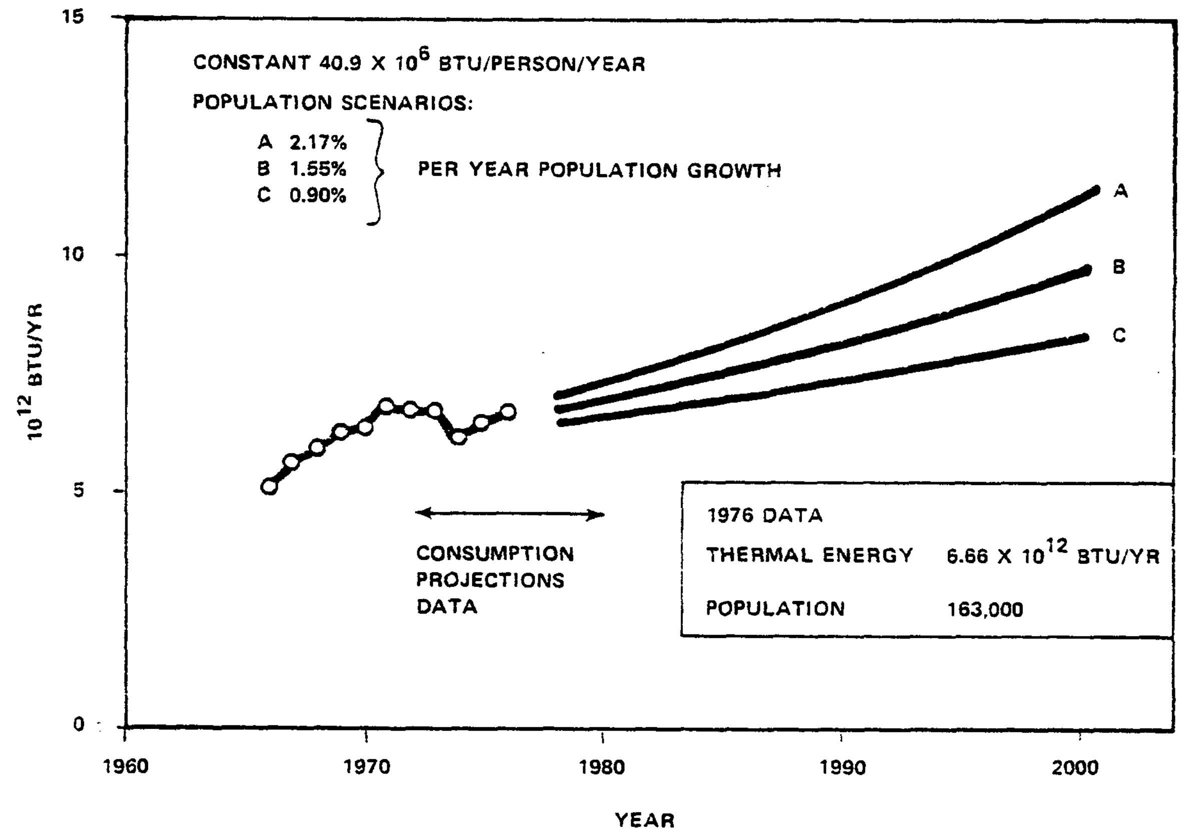

FIGURE 27. HISTORICAL GROWTH AND PROJECTIONS FOR THERMAL ENERGY REQUIREMENTS

TABLE 33. NUMBER OF VEHICLES AND FUEL USE FOR 1976 AND PROJECTED FOR THE YEAR 2000 FOR THREE POPULATION GROWTH SCENARIOS*

	1976			Projections to the Year 2000								
				Low Growth (0.90 %/yr)			Moderate Growth (1.55 %/yr)			High Growth (2.17 %/yr)		
	Number of Vehicles	Fuel Use		Number of Vehicles	Fuel Use		Number of Vehicles	Fuel Use		Number of Vehicles	Fuel Use	
		10^6 Gallons	10^9 Btu		10^6 Gallons	10^9 Btu		10^6 Gallons	10^9 Btu		10^6 Gallons	10^9 Btu
Private Autos and Trucks	93,631	45.7	5,480.8	115,297	56.2	6,746.4	132,815	64.7	7,768.8	155,595	75.9	9,108.0
Public and Fleet Vehicles	11,700	1.4	168.0	15,313	1.7	208.3	19,915	2.0	243.6	20,308	2.3	380.6
Total	105,331	47.1	5,648.8	130,610	57.9	6,954.7	152,730	66.7	8,012.4	175,903	78.2	9,388.6

* For assumptions and details concerning these data, see the calculations in Appendix C-3.

CANDIDATE CONSERVATION AND ALTERNATIVE ENERGY SUPPLY OPTIONS

The purpose of this activity was to develop a "laundry list" of options for screening. Those most appropriate for Riverside would then be selected for further evaluation. As a result, candidate conservation and alternative energy supply options applicable to the City of Riverside are presented in this section. The options listed included only those over which the City of Riverside could have direct control. For instance, development of a large scale oil industry or large coal gasification/liquefaction plant at the nationwide level was not considered a part of this study. Larger global issues (i.e., an oil embargo imposed by Middle Eastern countries, nationwide gasoline rationing, war, a national or regional four-day work week) were not considered in any detail in this study because they were outside the control of the City of Riverside. Also, in identifying these options, it was assumed that the City would continue to be in the utilities business although it was recognized that it is capable of taking charge of, or participating in, the management of either centralized or decentralized energy production systems.

Conservation

The purpose of this part of the study was to identify various conservation options for Riverside. Options were identified in the categories of buildings, community design, industry, and transportation. Later, these were to be screened and the surviving candidate options would be evaluated. Finally, the remaining options were to be combined with the alternative energy supply options in order to form the recommended alternative energy strategies for Riverside.

Candidate Conservation Options in Buildings

Based upon Battelle's analysis of the extent that building energy conservation has had in Riverside, it is clear that although the City of Riverside has implemented some operations-related conservation measures in municipal buildings and along with the Southern California Gas

Company and the Chamber of Commerce has implemented a conservation program to encourage reductions in electrical usage among large industrial and commercial comsumers, there is a need for expanding and intensifying energy conservation efforts in Riverside significantly. It is also evident that the implementation of the new statewide building code will increase the energy efficiency of newly constructed buildings. Two significant shortcomings exist in this present thrust to conserve energy in Riverside buildings. These are:

- The absence of a concerted, locally controlled and systematic program to conserve the energy used in buildings.
- The lack of programs directed at upgrading the energy efficiency of the largest and most significant component of Riverside's building inventory--the existing building.

The scope of this activity includes an investigation of energy conservation options relating to (1) increased energy-efficiency in new buildings, and (2) increased energy-efficiency in existing buildings.

The building energy conservation options* for the City of Riverside are as follows:

Assure Optimum Administration of New Residential and Nonresidential State Energy Code. Since the new State code took effect in July of 1978, a careful analysis should be made immediately to determine whether all needed services and capabilities are available for vigorous administration.

Although the administration of this code is mandated by the State of California, local jurisdictions will be responsible for administration. As a result, the quality of code interpretation and enforcement will depend upon the ability of Riverside's building and construction inspectors to perform this function. Inadequate staff with insufficient training will therefore prevent an optimum administration of these new codes. If Riverside cannot apply its own resources to provide sufficient

* A more detailed discussion is given in Volume 2, Appendix C1.

staff with proper training, or if the City cannot obtain assistance from other sources to make such provisions, the implementation of the program will suffer. Actions that should be taken immediately are:

- To assess whether or not the present manpower can sufficiently handle the additional workload created by the administration of the new code requirements.
- To assess whether staff has the understanding and knowledge required for exact and fair administration of the new code.
- To prepare staff increase requests and to hire new staff if additional inspectors and code administrators are needed.
- To prepare or seek training programs for staff if better understanding and knowledge of the new code are needed.
- To inform the local construction industry (architects, builders, developers, etc.) of the existence and nature of the new code requirements.

Increase Energy Efficiency of Existing Buildings. The lack of regulation of energy consumption in existing buildings will have a severe effect on the use of energy in the next few years. An energy code applicable to renovations, alterations, and retrofit of existing buildings could be developed. The retrofit code could be equivalent to the State's energy code for new construction. Although opposition is expected from building owners and especially from business and industry, no permits for major rehabilitation, maintenance, or repairs should be issued unless the building meets the retrofit energy code.

Continue to Improve Energy Codes for New and Existing Buildings. As the technology and efficiency of various conservation materials, products, and equipment improve and as the cost of scarce fossil fuels increases, standards and criteria for energy-efficient design and construction may need to be upgraded. As a result, development and recommendation of new standards for improving the existing energy codes (new construction and retrofit) will be needed.

Candidate Conservation Options in Community Design

The objective of this task was to investigate and identify candidate energy conservation options in community design and recommend those opportunities appropriate for energy-efficient new and retrofit community development.

The scope of this activity relates to an investigation of candidate conservation options in (1) community development patterns; (2) passive solar design of both buildings and the community; (3) landscaping and building shielding; and (4) street lighting. In this study, the conservation options presented include only those over which the City of Riverside would have direct control. For example, certain planning activities (i.e., changes in land use, building code, zoning ordinance) that may be controlled by the City are presented. On the other hand, for instance, the State of California has responsibility for the freeway lighting system and the City has no direct control over its operation; therefore cases such as these are not covered in this report.

Community Development Patterns. Although the general impact of land use on energy consumption is understood, identification of the specific land use patterns that are most energy efficient are not yet known. There are, however, certain land use actions that seem to reduce energy consumption. This includes clustering of dwelling units, reducing house and lot size, and providing concentrated planned developments of mixed uses to allow people to live nearer their place of work, shopping, and recreation. Compact development will reduce extensive use of the automobile and reduce fuel consumption as well. All of these actions fall within the domain of City planning and land use regulation.

Smaller, more dense housing has less wall and roof surface exposed to outside air. As a result, heating and cooling requirements are reduced. Additionally, more compact development, combined with open space, will also reduce the total area covered by pavement, thus lowering the temperature of the City's microclimate and reducing cooling loads.

Conservation options* identified in this section were:

(1) Reduction of minimum lot sizes

(2) Reduction of building size

(3) Encouraged use of more multifamily structures

(4) Encouragment of energy-efficient, concentrated planned neighborhood developments with mixed uses

(5) Expanded implementation of the commuter bicycle route plan

(6) Development of a pedestrian walkway system

(7) High-density planned development.

Reduction of Minimum Lot Size. Planning policies that encourage large lots have been a contributor to sprawl. Lot sizes, however, do not in themselves contribute to sprawl unless there is a maximum population limit.

Reduction of Building Size. Smaller dwelling units constructed according to energy-efficient design standards require less energy for heating and cooling and are less expensive. As the costs of housing increase, there will be a tendency to construct smaller dwelling units. Also, with implementation of the State energy code, new dwelling units will be energy efficient. While regulation of building size will lower energy consumption, public acceptance of such a regulation would probably offer a major constraint primarily because the public would perceive such action as encouragement for low-income families to move into the community. Further, if implemented, the option would not likely provide significant savings because most speculative homebuilders do not build a minimum-size home or purchase a minimum-size home.

Encouraged Use of Multifamily Structures. Energy savings increase dramatically in multi-unit structures. A responsible and concerned strategy aimed at reducing the number of single-family detached units in Riverside as a percent of the total appears to be a significant method for achieving energy savings. Although it is recognized that increased density is a major issue in Riverside, even an increase in the number of duplex and other low-rise multifamily units would make an impact of 30 percent savings over that of detached units.

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* A more detailed discussion is given in Volume 2, Appendix C4.

Encouragement of Energy-Efficient Planned Neighborhood Developments With Mixed Land Uses. This would have a profound effect on energy savings primarily in saving transportation fuel. This land-use pattern--concentrating shopping, employment, education, and recreation into villages--would foster the use of mass transit, bicycles, and walking and thus reduce the total distance to be traveled as well as the frequency of vehicular traffic. Further, such villages within the larger context of the City would provide an opportunity for an integrated utility system. Concentrated planned developments with mixed uses can be accomplished by more flexible zoning such as planned unit development (PUD) or a special permit process that provides for discretionary review of development.

Expanded Implementation of the Commuter Bicycle Route Plan. While there is a need to implement more of the existing bicycle commuter plan, it should be done so with as little conflict as possible between drivers and bicyclists. This could best be done as an integral feature of the concentrated planned neighborhood developments where bikeways, bike racks and lockers, service areas and landscaping (shading) can be made an inherent part of the plan and an effective means of encouraging bicycle transportation. Besides including this feature in the concentrated neighborhood development plan, additional segments of the existing bicycle plan should be implemented in the existing developed areas. These include:

- University Avenue, between Magnolia Avenue and University of California-Riverside
- Magnolia Avenue, between Third Street and Riverside College and between the College and La Sierra Avenue
- Arlington Avenue, between California Avenue and Chicago Avenue.

The purpose of expanding implementation of the existing commuter routes is to hasten fulfillment of the objectives of the bicycle master plan which are:

(1) To educate the motorist and the bicyclist, thus assuring that they are fully aware of their rights and responsibilities toward one another as users of public rights-of-way

(2) To provide and encourage safe conditions for bicycle travel on public streets.

As the energy crisis heightens in Riverside, the community will be better prepared for accepting bicycles as part of an overall alternative energy system plan.

Development of Pedestrian Walkway System. This is another method for reducing the community's reliance on the automobile. Although this is not a significant energy saver as an independent element, it can be a part of an overall plan for saving energy. For example, it could be included as a part of the concentrated planned development strategy. Pedestrians require safe and convenient support facilities. Riverside could encourage walking by assuring that these types of facilities are available. Benches and shaded rest areas, walkway signals, and easements through cul-de-sacs are possibilities for effective ways to encourage pedestrian travel.

High-Density Planned Development. This form of housing typically requires the least amount of energy. Because of the density and population growth issues in Riverside, this option is not considered a viable one largely because of potential opposition, publicly and politically. However, a limited amount of high-rise residential units should be constructed in lieu of single-family detached dwelling units in Riverside.

Passive Solar Building and Community Design. Passive solar design concepts rely on natural energy, such as the sun, contain few mechanical parts or complex hardware, require little or no energy themselves, and tend to be low in cost. The primary requirements for properly designed passive systems entail providing mass within the structure, and thermal control into and out of the building. Over a period of days, the temperature of a building can be driven up or down by allowing heat in and using insulation to trap it within the mass of the structure. In summer, shading or shielding of building elements is a required part of the design. Actions considered in this category were:

(1) Proper lot orientation
(2) Flexibility of setback requirements
(3) Regulation of thermal performance of passively designed residences
(4) Regulation of shading or shielding of south-facing walls
(5) Regulation of shading in public parking lots
(6) Requirement for alternative paving materials in public parking lots
(7) Reduction in street width standards.

Proper Lot Orientation. Orientation of a building in relation to the sun can greatly affect energy usage. Other factors to be considered are the intensity, direction, swing, and deviation of sunlight, as well as the ability of the building design to control or collect heat. The City can take action relative to orientation which is supportive of passive solar design of buildings. The most direct way to accomplish proper building orientation is to orient the building sites so that they face north-south.

Flexibility of Setback Requirements. Proper building orientation for solar access may be precluded by existing setback and yard requirements. Traditionally, only lots on east-west streets will have the proper orientation. Proper orientation is possible on a north-south street if front and rear setbacks are eased and the building rotated to face south rather than face the street. This would be prohibited under Riverside's present subdivision regulations.

Regulation of Thermal Performance of Passively Designed Residences. Considerably better minimum winter performance standards can be developed relative to passive thermal systems than will be provided by the new State energy code. This can be done without unduly restricting designs, raising costs, or requiring new technologies. Considerable reduction in the real cost of housing can be achieved in buildings with good thermal performance by lowering utility bills. Additionally, the initial costs of improving the structure's thermal performance is typically offset, in whole or in part, by the resultant savings due to the smaller capacity heating and/or cooling equipment required for a thermally efficient structure. In climates such as Riverside's, supplemental heating equipment may not be required at all if the building is properly designed using south-facing glass and adequate thermal storage material.

Landscaping and Building Shielding. The rationale for this option is similar to that for regulating thermal design of passively designed residences. Technically, the two concepts should be included in the same standard. However, this option is presented separately because it could apply to existing as well as new single-family detached, duplex, other multifamily low-rise, and mobile home units.

mercury vapor, the Department should work carefully with local law enforcement officials. The reason: in a study done in 1974 by the Law Enforcement Assistance Administration, it was found that some law enforcement officers have had difficulty in identifying the color of people's hair or clothing.

Reduce Size of Lamps in New and Existing Lights. This appears to be a better option than either reducing the hours of active street lighting or deactivating selected street lights.

Reduce Hours of Active Street Lighting. This is not recommended because of the extent and cost of the physical modifications required, and the anticipated loss of physical security during the hours when lights would be out of service.

Deactivate Selected Lights. Turning off lights on both sides of the street or even on one side is a positive way of saving energy. However, this was not recommended because of the cost, degradation of the inoperative lights due to moisture accumulation, and property tax assessment inequities that become highlighted when taxpayers call to complain about lack of street lights.

Candidate Conservation Options In Industry

Characterization of Riverside's industry supports the idea that Riverside is basically a residential community. There are only two companies with more than 1000 employees and 32 with more than 100 employees. The smaller companies cover a variety of industry types. The large companies already have effective formal energy conservation programs, thus increased industrial energy conservation efforts will have to encourage actions by the smaller companies.

The increasing price of fuel and possible decreases in its stability of supply will be an automatic incentive for industry to implement energy conservation measures. Depending on the specific industry, there are three strategies for achieving energy conservation, namely, (1) product substitution and demand reduction that reduces demand for energy-intensive products or changes the product mix to a less energy-intensive blend, (2) housekeeping strategies that improve operation and maintenance of existing facilities, and (3) capital investment strategies that involve retrofitting of existing plants and/or installation of new equipment.

Given the diversity of industry types and sizes, it is impossible as part of this Program, to tailor energy conservation options to individual companies. Thus, the options identified and listed in this section apply to all Riverside industry. The options* are:

Continuing Education Program. Given that the larger companies already have effective formal energy conservation programs, a continuing education program could be developed with special emphasis on helping the many small companies understand and adopt energy conservation measures to suit their individual needs. The EPIC Program (Volume 2, Appendix C2, Attachment C2-1) could be the basis for this type of program.

Public Information Program. Case histories of conservation techniques and achievements of large and small industrial companies in Riverside could be published on a regular basis in the Riverside newspaper, Chamber of Commerce Newsletter, or other local newspapers.

Evaluation of Trends in Industrial Energy Use. Efforts should be made to relate the overall trends in industrial energy conservation activities to conservation activities in other segments of the public and private sector. For example, the City could develop and implement a mechanism for recording and maintaining overall trends in industrial energy use in Riverside. Upon verification these statistics could be published, periodically, in aggregate form.

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* A more detailed discussion is given in Volume 2, Appendix C2.

Candidate Conservation Options in Transportation

The people of Riverside are nearly 100 percent oriented toward and dependent upon the automobile as their means of transportation. Although there is some bus service, this alternative is simply not feasible or convenient for most people. The bus system is primarily used by people in Riverside who do not have access to an automobile. While Riverside does have a modest degree of locally based employment, there are large numbers of people who have chosen to live in Riverside and commute to employment located outside the City and the County of Riverside. This situation results in a higher usage of gasoline. Gasoline is a fuel that must be conserved and, ultimately, it is a fuel upon which we can no longer be as dependent.

The best method of reducing fuel usage is to use transportation other than the personal automobile. Options* available to the people of Riverside are:

Car/Van Pools. Car/van pool programs have been available to the people in Riverside and surrounding counties for some time now. These programs are not popular, and it is debatable whether they can be called a success in Riverside.

Car and van pooling, especially to and from work or shopping, is one of the best ways that the people of Riverside can reduce fuel. However, these fuel savings are far from being realized. People are simply not willing to put up with the inconvenience of pooling (this is generally true across the United States). A means to compel the American people into pooling without being forced by a crisis situation has eluded and frustrated pooling proponents for years. A variety of incentives have been tried in this country, and in a few cases these incentives have met with some success, such as the car/van pool express lanes into Washington, D.C. from Northern Virginia. However, no incentive has really been universally successful. Consequently, widespread pooling has not occurred in Riverside nor in the rest of the United States. However, car and van pools are viable and important transportation alternatives.

* A more detailed discussion is given in Volume 2, Appendix C3.

Public Transit. The Riverside Transit Agency provides a bus service within the City of Riverside which primarily caters to those people who do not have access to the automobile, such as students and the elderly. This service is probably also a source of transportation for some people to get to work, shopping, etc., but this is only a supposition. Most likely the service could be used by more people for trips within the City, but available information suggests that a survey study would be required to determine the extent to which this service could be utilized.

The City of Riverside is included in the Rapid Transit District (RTD), and there is some bus service from the City to the surrounding cities and counties. This service is limited and the routes are not convenient for most people in Riverside who work in and commute to the surrounding cities and counties. Consequently, this service, in its present form, is a limited transportation alternative for most people.

There is also a Dial-a-Ride program for the elderly and handicapped, but this service is not a transportation alternative for the general public of Riverside. The hydrogen bus experiment* is a part of this program. As stated previously, an alternative fuel is the ultimate answer to transportation needs. The hydrogen bus represents the beginning of experiments with alternative fuels. It remains to be seen whether the bus will demonstrate that hydrogen can be used in a cost-effective manner.

Bicycles, Mopeds, Motorcycles, and Walking. These alternative methods of transportation are available to the people of Riverside, but have not been perceived yet as a practical solution to the transportation problem.

Since 1973, the City has taken a number of steps to implement the proposed Master Plan of Bikeways. Commuter bike routes have been established on (1) Magnolia Avenue, between Jurupa Avenue and Riverside City College (located at the corner of Magnolia and Terrociva); (2) California Avenue, generally between Jefferson Street and MacArthur Road; (3) Linden Street, between Chicago Avenue and Canyon Crest Drive: (4) Canyon Crest Drive, between Blaine Street and University Avenue; (5)

* Presently, as discussed later, the City of Riverside is conducting an experiment using a hydride-storage hydrogen-powered bus. This experimental vehicle has suffered problems and has not been subjected to prolonged use.

Big Springs Road, between UCR and Mt. Vernon Avenue; (6) Watkins Drive, between Blaine Street and Valencia Hill Drive, and between Picacho Drive and the Escondido Freeway; and (7) La Sierra Avenue, generally between Five Points and the Riverside Freeway. All of these routes have been established as Class II* facilities with the exception of the Linden Street bike route, which consists of both Class I and Class II facilities. A Class I* bikeway has been established along Victoria Avenue, between Van Buren Boulevard and Myrtle Street, a distance of 5-1/2 miles.

Those persons who can use these alternatives for getting to work and shopping near to their homes should do so.

Alternative Energy Supply Options

A variety of energy sources exist that can be classed as nonscarce alternatives to natural gas and oil in Southern California. Among them are solar, wind, geothermal, refuse/biomass, coal, and nuclear energy. These alternative energy sources can be integrated into energy systems comprised of various permutations of conversion, transmission and end use technologies almost too numerous to mention. Figure 28 illustrates the plethora of system possibilities that exists for carbonaceous fuels such as coal, refuse, and biomass alone. This figure is simplified in that it does not list specific technology alternatives along the conversion path.

It was therefore not the intent of this part of the study to select the optimum energy system based on alternatives to natural gas and oil for Riverside. Such an optimum can be defined only when relative weights are given to specific optimization criteria, such as economics, environmental impact, efficiency of resource utilization, public acceptance, and others. These relative weights as well as the definition of each criterion are in many ways subjective in nature and will vary depending on the perspective of the person or persons involved. This fact underlines the importance of community involvement and interaction in the energy selection process.

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* Class I - recreational cycling
Class II - commuter cycling

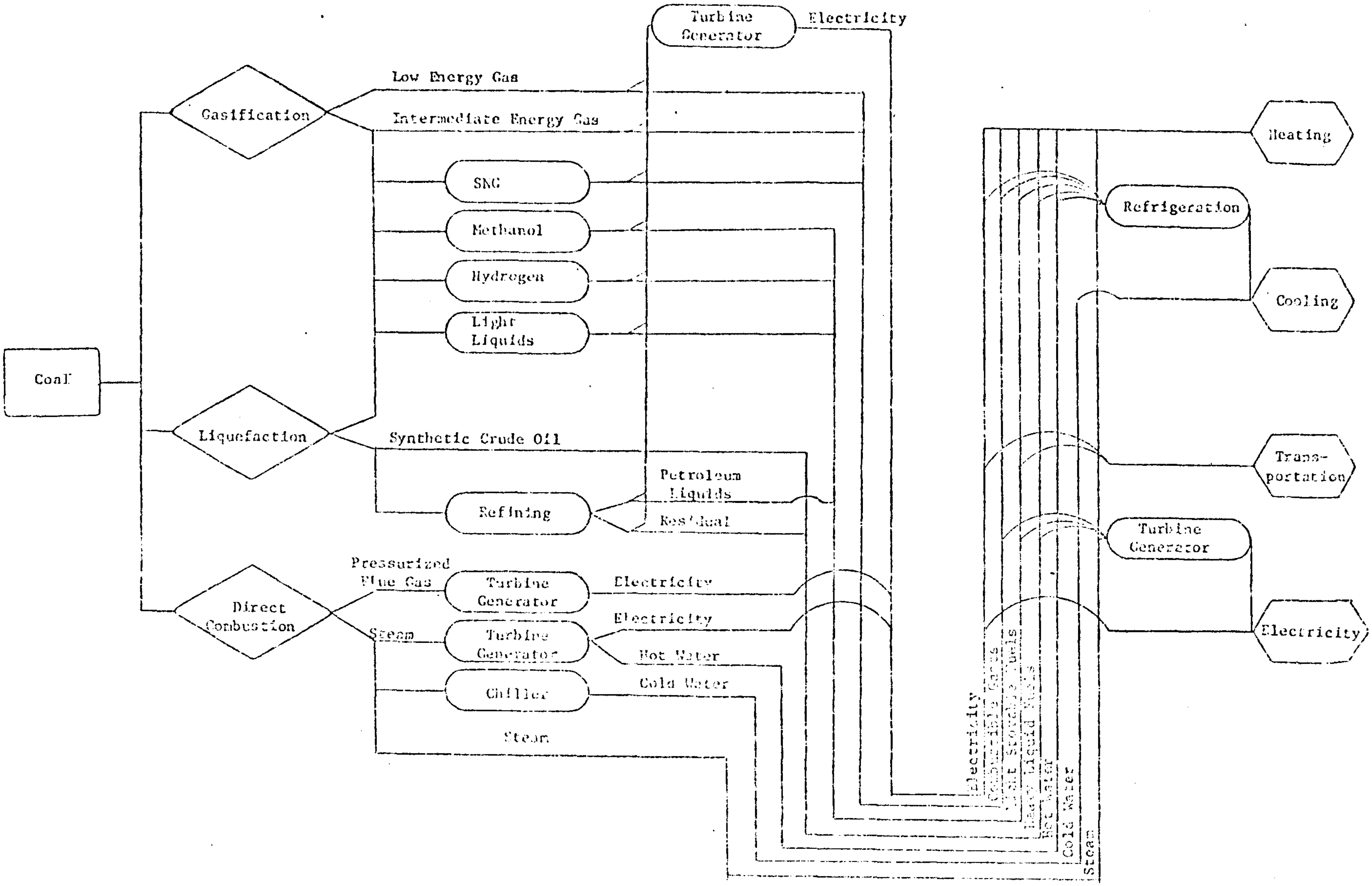

FIGURE 28. COAL CONVERSION AND DISTRIBUTION ALTERNATIVES

The purpose of this part of the study was to provide definition of various alternative energy supply options for Riverside to act as a basis for Battelle's recommendations and for subsequent consideration by the Riverside community and its various interest groups. These are options whose implementation and operation would be substantially influenced by the community, thus providing Riverside with more direct control and responsibility for satisfying its energy needs. However, it must be clearly understood that the community energy systems philosophy is a departure from the utility network philosophy that has been the dominant form of energy supply in this country during the recent past. A transition to community energy-type systems will require substantial time, and during the interim Riverside must continue to rely on purchases of energy from utility systems.

The following is a brief discussion of considerations given to each of the alternative energy resources as they apply primarily to stationary end use consumption (buildings). The reader is referred to Appendix D for more detailed discussion and background information on each of the alternative energy resources. At the end of this section is a separate listing of options initially considered for vehicular application. For more detailed discussion of use of alternative fuels in vehicles the reader is referred to Appendix C3.

Coal

California has no substantial reserves of indigeneous coal. However, nearby states such as Utah and New Mexico do. Utah is the most likely source of coal for Riverside and in fact is the current source of coal for the Riverside Cement Company in Rubidoux. Technology is currently available for substantially reducing the environmental impact associated with the use of coal. Developing technology promises lower environmental impact, higher efficiency, and lower costs than conventional technology.

Coal can be burned directly or converted into a clean gaseous or liquid fuel. Options initially considered for application of coal in Riverside were the following:

1. Combustion of coal in a boiler facility with generation of steam for heating, cooling, and electricity in an integrated utility system.

2. Gasification of coal with use of the gas in a combustion turbine or fuel cell for electricity generation followed by steam generation from waste heat for heating and cooling in an integrated utility system.

3. Gasification of coal to a low or intermediate heating value gas for distribution and use as a fuel gas.

4. Conversion of intermediate heating gas to hydrogen followed by distribution and use of gas as fuel for fuel cells and vehicles.

5. Conversion of intermediate heating value gas to methanol with same uses as for hydrogen.

6. Combustion of coal in a remotely located base load electric generating facility with electricity shipped to Riverside over utility transmission lines.

Active Solar Systems

Consideration of the use of solar energy is especially appropriate for Southern California because of favorable climatic characteristics. Options initially considered were:

1. Heating of domestic hot water with flat-plate collectors

2. Space heating with flat-plate collectors

3. Steam production through concentrating collectors for process use

4. Cooling through absorption cooling cycles

5. Electricity generation through photovoltaic cells.

Wind

The wind is, like solar energy, a nondepletable energy resource which at present is not being exploited to any great extent. Two options were identified as being worthy of consideration.

1. Deployment of wind machines in Riverside with production of electricity

2. Construction of a wind machine in San Gorgonio Pass (about 35 miles east of Riverside) for generation of electricity which would then be shipped to Riverside over utility lines. San Gorgonio Pass is a known area of high wind potential.

Refuse/Biomass

A recent study of landfill alternatives in the Riverside area indicates that there is currently about 500 to 550 tons of refuse per day that could be available for energy recovery. Options initially considered for application in Riverside were the same as those listed for coal utilization except for coal option 6 involving generation of electricity at a remotely located power plant. This option was not considered because of the impracticality of shipping refuse to remotely located plants.

Geothermal

There are sufficient geothermal resources within 200 miles to supply the electric requirements of Riverside for thousands of years. The technology for producing electricity from these resources is either in-hand or in-sight. Depending on the particular reservoir involved, this electricity can probably be generated at costs ranging from 1 to 3 times the cost of conventional electric power generation. Over this distance, the additional unit cost for energy transmission should be comparatively small.

A geothermal resource at nearby Arrowhead Hot Springs may have the potential to supply space heating and cooling and process heat to Riverside for a hundred years. The technology for these nonelectric uses is available. The cost of using geothermal energy for these applications is estimated at 1 to 2 times the cost of conventional fuels, depending on the population density of the service area.

Options for application of geothermal energy initially considered for Riverside were:

1. Investment in remote electric generating facilities in the Imperial Valley,or elsewhere,as appropriate with electricity shipped to Riverside over long-distance transmission lines.

2. Use of geothermal energy from nearby Arrowhead Springs for district heating and cooling in Riverside.

Nuclear

Nuclear energy, like coal and refuse, can also be used in the integrated utility framework for generating electricity while satisfying heating and cooling requirements. Also, like coal, nuclear energy is attractive for use in large base-load electric generating plants. Nuclear options initially considered for Riverside were:

1. Use of nuclear energy to generate steam for heating, cooling, and electricity in an integrated utility system in Riverside.

2. Use of nuclear energy in remotely located electric generating stations that are currently under consideration by Riverside.

Transportation

Vehicles in Riverside are major consumers of scarce petroleum and major contributors to atmoshperic pollutants. Alternative fuel options considered in this study were directed at Riverside's captive Fleet, where the City of Riverside can exert control over fueling and vehicle conversion. These vehicles might serve then as demonstrations to stimulate application of alternative fuels in the private sector. Specific options considered initially were:

1. Use of electric vehicles
2. Conversion of vehicles to facilitate use of hydrogen produced from coal, refuse, or electrolysis of water
3. Conversion of vehicles to facilitate use of methanol made from coal or refuse.

SCREENING OF OPTIONS

This section discusses the methodology used by Battelle to screen the candidate conservation and alternative energy supply options as identified earlier.

The purpose of conducting this preliminary evaluation is as follows:

- To identify and select those options that are most applicable and beneficial to the City of Riverside, considering the goals of the Program.
- To identify evaluation criteria that are consistently applicable to the options identified.
- To verify the consistency of these criteria as the candidate options are analyzed.
- To display this preliminary analysis so that others may better understand the screening and selection process.

Generally, each option is judged in relation to each evaluation factor and a set of evaluation impacts/affects scaled to range from 0 to 10--with 0 being the worst and 10 the best. After all of the candidate options were evaluated, scores were developed for each option and the options were ranked separately for conservation and alternative energy supply.

Conservation

To initiate screening of the candidate conservation options, all of the building, community design, industry, and transportation conservation options were listed in a matrix with the evaluation criteria (Table 34).

Each option was then judged in relation to each evaluation factor and a set of evaluation impacts/effects scaled to range from 0 to 10. The evaluation factors, their impacts/effects, and the numerical values for each are shown in Table 35.

TABLE 34. SCREENING OF CANDIDATE CONSERVATION OPTIONS BY SELECTED EVALUATION FACTORS

CONSERVATION OPTIONS	TECHNOLOGY AVAILABILITY	ENVIRONMENTAL IMPACT	LEGAL/ INSTITUTIONAL	PUBLIC ACCEPTANCE	EXPECTED COST EFFECTIVENESS	NET SAVINGS OF ENERGY RESOURCES	ABILITY TO DISPLACE NATURAL GAS OR FUEL OIL	SCORE	RANK	CATEGORY[a]
Buildings										
New Energy Code	10	6	10	10	10	6	5	57	3	***
Retrofit Energy Code	10	7	3	3	9	10	10	52	6	**
Community Design										
Modify Housing Mix	10	6	3	3	10	7	6	45	10	*
Energy Efficient Neighborhood Development	10	8	3	4	10	9	10	54	4	**
Passive Thermal Standards	5	9	5	6	10	6	7	48	9	*
Passive Cooling Standards	8	5	6	6	10	7	10	52	6	**
Convert Incandescent Street Lamps	10	5	10	10	7	5	2	49	8	*
Reduce Consumption of Street Lighting	10	5	9	10	8	6	5	53	5	**
Expand Commuter Bicycle Route	10	10	5	3	8	7	7	50	7	**
Reduction of Minimum Lot Size	10	1	3	3	5	4	1	27	16	
Reduction of Building Size	10	5	5	5	7	5	1	38	12	
Pedestrian Walkways	10	6	6	4	4	5	1	36	13	
High-Density Planned Development	10	10	0	0	10	10	10	50	7	**
Solar Lot Orientation	10	10	5	6	10	10	10	61	1	***
Flexibility of Setback Requirements	10	5	5	6	10	5	4	45	10	*
Regulate Shading in Parking Lots	10	6	3	4	1	5	1	30	15	
Require Alternative Paving Materials in Public Parking Areas	10	4	2	3	1	4	1	25	17	
Reduce Street Width Standards	10	5	2	3	5	5	2	32	14	
Reduce Hours of Active Street Lighting	10	5	5	3	6	6	1	36	13	
Deactivation of Selected Street Lights	10	5	5	1	3	6	2	32	14	
Transportation										
Car Pools/Van Pools	10	8	2	2	8	10	8	48	9	*
Buses	10	8	4	3	9	10	9	53	5	**
Mass Transit (Commuter Buses & Trains)	10	9	1	2	10	10	10	52	6	**
Purchasing Fuel-Efficient Vehicles	10	7	10	10	7	10	4	58	2	***
Efficient Driving Behaviors	10	6	10	10	6	6	2	50	7	**
Efficient Route Planning	10	5	10	8	5	5	1	44	11	

(a) Category Definition
*** Score > 55
** Score 50-54
* Score 45-49

TABLE 35. SCREENING EVALUATION CRITERIA FOR CONSERVATION OPTIONS

Factor	Impact/Effect	Values
Technological Availability	• Limited commercialization	0
	• Moderate commercialization	5
	• Extensive commercialization	10
Environmental Impact	• Probable negative impact	0
	• Uncertain impact depending on application	5
	• No impact	5
	• Definite beneficial impact	10
Legal/Institutional	• Major changes/probable major political opposition	0
	• Some changes/some political opposition	3
	• Some changes/no political opposition	6
	• No changes/some political opposition	6
	• No changes/no political opposition	10
Public Acceptance	• Unacceptable	0
	• Indifferent	5
	• Definitely acceptable	10
Expected Cost Effectiveness	• Life cycle costs higher than current trends	0
	• Life cycle costs about same as current trends	5
	• Life cycle costs lower than current trends	10
Net Savings in Community Energy Resources	• Uses more energy	0
	• No significant impact	5
	• Significant savings	10
Ability to Displace Natural Gas or Fuel Oil	• No displacement	0
	• Some displacement	5
	• Significant displacement	10

In conducting the analysis, scores and relative rankings were then developed for each option. As a result of this evaluation, conservation options that were recommended for further in-depth evaluation are shown in Table 36.

TABLE 36. CONSERVATION OPTIONS RECOMMENDED FOR IN-DEPTH EVALUATION

Category	Options
***	• New State energy code • Solar lot orientation • Purchasing fuel-efficient vehicles
**	• Energy-efficient neighborhood development • Increase usage of buses • Reduce consumption of street lighting • Retrofit energy code • Mass transit • Passive cooling standards • Expand commuter bicycle routes • High-density planned developments • Efficient driving behaviors
*	• Convert incandescent street lamps • Car pools/van pools • Passive thermal standards • Modify housing mix • Flexibility of setback regulations

It should be emphasized that the above options have been ranked and selected based upon a set of criteria and not upon whether one option conserves more energy than another or whether one option is more cost effective than another. Also, only the relative ranking of the option is important (i.e., whether it is in the top, middle, or lower third) and not whether one option immediately precedes or follows another. In addition, although high-density planned development ranked among the top 10, it was eliminated from further analysis based upon current local opposition.

Alternative Energy Supply

Screening of the candidate alternative energy supply options (Table 37) was performed in a manner similar to that used to screen the conservation options.

TABLE 37. SCREENING OF CANDIDATE ALTERNATIVE ENERGY SUPPLY OPTIONS, BY SELECTED EVALUATION FACTORS

ALTERNATIVE ENERGY RESOURCE OPTIONS	LONGEVITY OF RESOURCE BASE	RELIABILITY OF ENERGY SUPPLY (NORMAL)	RELIABILITY OF ENERGY SUPPLY (UPSET)	ENVIRONMENTAL IMPACT	ABILITY TO DISPLACE NATURAL GAS OR OIL	TECHNOLOGY AVAILABILITY	EXPECTED COST EFFECTIVENESS	PUBLIC ACCEPTANCE	SCORE	RANK	CATEGORY[a]
Solar											
1. Water & Space Heat	10	5	8	10	5	8	7	10	63	1	****
2. Steam, Electric Production	10	3	6	10	2	5	3	7	46	12	*
3. Photovoltaic Electric	10	3	8	10	1	3	3	10	48	10	*
4. Thermochemical H_2	10	5	6	10	1	0	0	10	42	16	
Coal											
1. Remote Generation	5	10	5	8	5	10	8	3	54	4	**
2. Integrated Utility System											
a. Conventional Combustion	5	8	8	4	7	9	4	2	47	11	*
b Gasification Gas Turbine	5	6	7	8	10	6	7	4	53	5	**
c. Gasification Fuel Cell	5	6	7	7	10	4	8	4	52	6	**
d. Pressurized Fluid Bed	5	6	7	5	10	6	8	4	51	7	**
3. Gasification											
a. Low Energy Gas	5	7	8	6	5	7	4	4	46	12	*
b. Hydrogen	5	5	7	9	6	6	2	6	46	12	*
c. Methanol	5	4	6	8	7	6	1	6	43	15	
4. Liquefaction	5	5	3	7	7	4	2	3	36	21	
5. Combustion at End Use	5	5	8	0	4	9	0	0	31	22	
Refuse											
1. Integrated Utility System											
a. Conventional Combustion	10	5	8	3	5	9	2	3	45	13	*
b. Gasification Gas Turbine	10	4	6	8	7	5	5	5	50	8	**
c. Gasification Fuel Cell	10	4	6	7	7	4	7	5	50	8	**
d. Pressurized Fluid Bed	10	4	6	6	7	5	6	5	49	9	*
2. Gasification											
a. Low Energy Gas	10	5	8	6	4	6	4	5	48	10	*
b. Hydrogen	10	4	7	9	4	4	2	6	46	12	*
c. Methanol	10	3	6	8	4	4	1	6	42	16	
3. Landfill Recovery (Methane)	10	5	8	8	1	6	8	8	54	4	**

TABLE 37. SCREENING OF CANDIDATE ALTERNATIVE ENERGY SUPPLY OPTIONS, BY SELECTED EVALUATION FACTORS (Continued)

ALTERNATIVE ENERGY RESOURCE OPTIONS	LONGEVITY OF RESOURCE BASE	RELIABILITY OF ENERGY SUPPLY (NORMAL)	RELIABILITY OF ENERGY SUPPLY (UPSET)	ENVIRONMENTAL IMPACT	ABILITY TO DISPLACE NATURAL GAS OR OIL	TECHNOLOGY AVAILABILITY	EXPECTED COST EFFECTIVENESS	PUBLIC ACCEPTANCE	SCORE	RANK	CATEGORY[a]
4. Anaerobic Digestion (Methane)	10	5	7	8	1	4	2	7	44	14	
Biomass											
1. Agricultural Residues											
a. Combustion	4	8	8	6	1	9	2	3	41	17	
b. Gasification	4	6	6	6	1	7	1	6	37	20	
c. Biological Conversion	4	6	6	8	1	5	0	6	36	21	
2. Timber Wastes											
a. Combustion	8	9	8	6	1	9	2	3	46	12	*
b. Gasification	8	6	6	6	1	7	1	6	41	17	
c. Biological Conversion	8	6	6	8	1	5	0	6	40	18	
3. Feedlot Manure											
a. Combustion	4	8	7	6	1	8	2	3	39	19	
b. Gasification	4	6	7	6	1	6	2	3	39	19	
c. Biological Conversion	4	8	8	8	2	8	8	6	52	6	**
Nuclear											
1. Remote Generation	7	10	5	9	5	10	9	2	57	3	***
2. Integrated Utility System	7	7	7	8	7	8	4	1	49	9	*
Wind											
1. Local Electric	10	3	5	10	1	9	0	8	46	12	*
2. Remote Electric	10	5	3	10	2	9	3	7	49	9	*

TABLE 37. SCREENING OF CANDIDATE ALTERNATIVE ENERGY SUPPLY OPTIONS, BY SELECTED EVALUATION FACTORS (Continued)

ALTERNATIVE ENERGY RESOURCE OPTIONS	LONGEVITY OF RESOURCE BASE	RELIABILITY OF ENERGY SUPPLY (NORMAL)	RELIABILITY OF ENERGY SUPPLY (UPSET)	ENVIRONMENTAL IMPACT	ABILITY TO DISPLACE NATURAL GAS OR OIL	TECHNOLOGY AVAILABILITY	EXPECTED COST EFFECTIVENESS	PUBLIC ACCEPTANCE	SCORE	RANK	CATEGORY[a]
Hydroelectric											
1. Remote Electric Generation	10	10	5	8	1	10	10	7	61	2	****
Geothermal											
1. Remote Electric Generation	8	8	5	9	3	7	5	5	50	8	**
2. Integrated Utility System	5	6	7	8	3	2	7	5	43	15	

(a) Category definition
**** Score > 60
*** Score 55-60
** Score 50-55
* Score 45-50

All of the alternative energy supply options were listed in a matrix with selected evaluation criteria.

Each option was then judged in relation to each evaluation factor and a set of evluation impacts/effects scaled to range from 0 to 10. The evaluation factors, their impacts/effects, and the numerical values for each are listed in Table 38.

TABLE 38. SCREENING EVALUATION CRITERIA FOR ALTERNATIVE ENERGY SUPPLY OPTIONS

Factor	Impact/Effect	Values
Longevity of Resource Base	• Depletable resource - (natural gas, oil)	0
	• Nondepletable resource - (solar, geothermal)	10
Reliability of Energy Supply	• Systems having an established history of reliability under normal conditions (remote nuclear and coal-fired plants)	10
	• Systems that require backup or involve higher complexity (solar, hydrogen from coal)	0
Reliability of Energy Supply	• Systems with low reliability under possible upset conditions (oil embargo, coal strike)	0
	• Systems with high reliability under possible upset conditions	10
Environmental Impact	• Definite beneficial impact	10
	• Probable negative impact	0
Ability to Displace Natural Gas or Oil	• Significant displacement (include flexibility of option)	10
	• Minimal or no displacement	0

Factor	Impact/Effect	Values
Technological Availability	• Not expected to be developed in the near term or limited commercialization	0
	• Extensive commercialization	10
Expected Cost Effectiveness	• Life cycle costs higher than current trends	0
	• Life cycle costs lower than current trends	10
Public Acceptance	• Unacceptable	0
	• Definitely acceptable	10

In Conducting the screening, score and relative rankings were then developed for each supply option. As a result of this evaluation, alternative energy supply options that were recommended for further in-depth analysis are presented in Table 39.

TABLE 39. ALTERNATIVE ENERGY SUPPLY OPTIONS RECOMMENDED FOR IN-DEPTH EVALUATION OPTIONS

Category	Options
****	• Solar water and space heating • Hydroelectric - remote electric generation
***	• Nuclear - remote electric generation
**	• Coal - remote electric generation

*	• Coal - remote utility system
	  • Gasification gas turbine
	  • Gasification fuel cell
	  • Pressurized fluid bed
	• Refuse - integrated utility system
	  • Gasification gas turbine
	  • Gasification fuel cell

Category	Options
	• Landfill methane recovery
	• Feedlot manure biological conversion
	• Geothermal - remote electric generation
*	• Solar - steam, electric generation - photovoltaic, electric generation
	• Coal - integrated utility system • conventional combustion - gasification • low-energy gas • hydrogen
	• Biomass - timber wastes • combustion
	• Nuclear - integrated utility system
	• Wind - local electric - remote electric

As with the conservation options, the options listed above have been ranked and selected based upon a set of criteria and not upon whether one option conserves more energy than another or whether one option is more cost effective than another. Also, only the relative ranking of the option is important (i.e., whether it is in the top, middle, or lower third) and not whether one option immediately precedes or follows another.

Hydroelectric power was one of the highest ranking options which evolved from the initial screening. Because Riverside has no indigenous hydroelectric resources, this option was considered in the same category as were remote coal and nuclear options, although the potential for the hydroelectric is considerably less than that for coal and nuclear. Investment in remote generating facilities has been studied in detail by the Riverside Public Utilities Department. These options were considered in this study for comparison purposes only.

EVALUATION OF SELECTED CONSERVATION AND ALTERNATIVE ENERGY SUPPLY OPTIONS

This section of the report discusses the methodology used by Battelle to evaluate the conservation and alternative energy supply options selected in the previous section and presents the results of the evaluation.

The conservation and alternative energy supply options are evaluated in terms of primary and secondary outcomes as well as feasibility of implementation.

Evaluation Methodology

Primary Outcomes

Primary outcomes cover the effect of conservation and alternative energy options on both total energy demand and environmental quality and are defined in this report, respectively, as:

(a) The amount of reduction in energy consumption and the amount of independence achieved through displacement of natural gas and oil

(b) The amount of reduction or increase in emissions for hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulates.

Effect on Total Energy Demand. In this evaluation, total energy demand is projected to the year 2000 assuming a business-as-usual environment in Riverside for the low (.9 percent), moderate (1.55 percent), and high (2.17 percent) population growth rate, as projected by Battelle. Business as usual is defined as no significant changes in lifestyle and per capita consumption of energy. In developing this projection, 1976 consumption data presented in the section entitled "Baseline Information" were used as a base. Estimates of energy savings were then calculated for the surviving conservation options (Volume 2, Appendix C1, Attachment C1-1; Appendix C2, Attachment C2-2; Appendix C3, Attachment C3-1; Appendix C4, Attachment C4-1). Estimates of displacement of natural gas, purchased electricity, and fuel oil were also calculated for the surviving attentive supply options (Volume 3, Appendix D). Each of these estimates are prepared for the year 2000 based upon a low, moderate, and high impact for the low, moderate, and high population growth rate. The difference between low, moderate, and high impact varies and is the degree to which the City might go to achieve certain savings. The savings and displacement estimates for each impact and each population growth rate were then superimposed over the business-as-usual projection to show the reduction in fuels used in Riverside in the year 2000. The reduced energy demand for natural gas and oil is made up from various alternative energy resources.

Effect on Environmental Quality. In this evaluation emission factors were selected for hydrocarbons, carbon monoxide, nitrogen oxides, sulfur dioxide, and particulates, by fuel type and end use (Table 40). Estimates of decrease in emissions were then calculated for the surviving conservation and alternative energy options by multiplying the emission factors times the energy savings. Each of these estimates are prepared for the year 2000 based upon a low, moderate, and high impact energy savings and for the low, moderate, and high population growth rates.

Secondary Outcomes

The implementation of an alternative energy strategy will generate numerous secondary outcomes, or impacts, which must be incorporated into the decision-making process. These are subtle and must be evaluated at a qualitative level only, such as the impact on residential privacy or lifestyle in the Riverside community. The secondary outcomes evaluated in this study included the local economy, energy supply stability, and lifestyle.

TABLE 40. EMISSION FACTORS

End Use	Fuel	Emission Factor (lb/10^6 Btu of Fuel)				
		Hydrocarbons	CO	NO_x	SO_2	Particulate
Residential[a]	Natural Gas	0.003	0.040	0.097	0.0006	0.006
Commercial[b]	Natural Gas	0.004	0.020	0.098	0.0006	0.006
Industrial[c]	Natural Gas	0.04	0.020	0.098	0.0006	0.006
	#2 Oil	0.001	0.004	0.177	0.187	0.009
Large Boiler (Power Plant)	Pulverized Coal	0.008[d]	0.02[e]	0.40[f]	0.10[g]	0.02[h]
	Refuse[h]	0.100	0.03	0.090	0.300	0.050
Gasifier/Gas Turbine	Coal/Refuse	0.004[i]	0.02[i]	0.120[j]	0.05[k]	0.010[i]
Gasifier/Fuel Cell	Coal/Refuse	0.004[i]	0.02[i]	0.030[j]	0.05[k]	0.09[j]
Large Boiler	Residual Oil[e]	0.053[m]	0.523[m]	0.700[n]	0.013[o]	0.0003[m]
	Natural Gas	0.006[m]	0.0006[m]	0.400[n]	0.040[o]	0.0004[m]
Remote Electric[p]	Oil/Natural Gas	0.018	0.00035	0.64	0.418	0.044
Transportation[q]	Gasoline	0.6	7.9	1.3	0.05	0.13

(a) Barrett, R.E., Miller, S.E. and Locklin, D.W., "Field Investigation of Emissions from Combustion Equipment for Space Heating" EPA-R2-73-084a API Publication 4180 June 1973.

(b) Jahnke, J.A., Cheney, J.L., Rollins, R., and Fortune, C.R. "A Research Study of Gaseous Emissions from a Municipal Incinerator" APCA Journal Vol. 27 No. 8 August 1977.

(c) Assumed the same as commercial as per reference AP42. Oil emissions from reference (b).

(d) "Vapor-Phase Organic Pollutants" National Academy of Sciences, Document 182623, 1976.

(e) U.S. Public Health Service Publication No. 999-AP-24, 1966.

(f) Assumes low NO_x burners with pulverized coal firing (see Table D1-2).

(g) Assumes 90 percent removal of SO_2 from flue gas (see Table D1-2).

(h) "Draft of Standards Support and Environmental Impact Statement Volume I: Proposed Standards of Performance for Electric Utility Steam Generations Units (Particulate Matter)" U.S. EPA December 1977.

(i) Battelle estimate.

(j) "Engineering and Environmental Analysis of New Conventional and Advanced Combined Cycle Power Plants as Alternatives to Meet the Needs that are to be served by the Sundesert Nuclear Power Plant" Supporting Document 14 to Assembly Bill 1852, Burns and Roe, December 1977.

(k) Assumes 95 percent sulfur removal from both refuse and coal gasification. This is equivalent to about 60 ppmv of H_2S in low energy gas (see Table D1-3).

(l) "Compilation of Air Pollutant Emission Factors" U.S. EPA Document AP-42 February 1942.

(m) Assumed the same as residential/industrial/commercial.

(n) "Background Information for Proposed New-Source Performance Standards" U.S. EPA APTT 0711, August 1971.

(o) Assumed the same as industrial.

(p) Assumes Southern California Edison Fuel Consumption as 30 percent residual oil and 20 percent natural gas as per "Steam Plant Factors - 1977" from U.S. Federal Power Commission.

(q) "Integrated Community Energy Plan, Riverside, CA." Volume 2, Appendix C3, attachment C3.1, p. 4, Battelle Columbus, November 1978.

Modification of the Riverside energy demand profile and supply system will have numerous economic repercussions throughout the local economy. These, for example, might include:

- Increased activity in the construction industry and demand for related construction workers
- Attraction of new industries which seek stable, environmentally acceptable energy supplies
- Adjustment in the City's General Plan to provide for more energy-efficient neighborhoods, housing, and transportation, and the associated fiscal impacts of implementing such recommendations
- Local budgetary impacts associated with investments in, or management of, alternative fuel systems.

An important secondary outcome of switching to alternative energy resources is the impact on energy supply stability. Energy supply stability can be defined in numerous ways; in the present context, it refers to the ability of energy resources and their associated systems to dependably supply the energy needs of the end-use sector both in the long and short run. In the long run, the stability of alternative resources such as solar, geothermal, wind, coal, and wastes is well established. These resources will be available for our use in the foreseeable future, whereas natural gas and petroleum reserves are much more limited. However, short term stability, i.e., dependably supplying energy on a day-to-day basis, is a different concept. Because many alternative energy resources would be implemented and operated at the community level, the community will assume more responsibility and exercise more direct control in satisfying its own energy needs on a day-to-day basis. System backup and redundancy become important considerations in determining how the community relies on its own resources and what kind of relationship the community maintains with outside utilities. Addressed were the issues involved in both the long- and short-term energy supply stability picture relative to alternative energy resources.

Departures from the existing pattern of energy supply and demand within Riverside will result in some alteration of existing lifestyles.

A solar-based zoning ordinance might place restrictions on the orientation of structures, which, in turn may impact the traditional concepts of privacy. Similarly, other new design requirements such as thermal efficiency standards may affect the range of options available to the local builder and home buyer. On the other hand there may be benefits such as increased comfort due to the building retrofit program or a more leisurely environment in the case of the planned neighborhood development program. Other lifestyle adjustments may be necessary as a result of modifications in the energy supply system. To be cost effective, for example, the implementation of a waste-to-energy system may require shifts in the location and/or frequency of solid waste collection and disposal. Energy generated from such a system will require a physical plant and distribution system to which some Riverside residents may object on aesthetic grounds. These are a few of the many types of life-style impacts associated with the various energy strategies that were considered in the analyses of alternative strategies.

Feasibility

Also, to arrive at a realistic alternative energy strategy the feasibility of implementing each option was evaluated in terms of public acceptance, legal/institutional constraints, technology availability, and public and private sector costs.

Public acceptance and human behavioral aspects are a crucial consideration in the development of an integrated community energy plan. Without due attention to the human element in the process of planning and implementing strategies, technological and economic analyses are incomplete. Thus, in evaluating the feasibility of various energy options, the research team incorporated existing levels of public awareness and probable acceptance of energy-related policy changes and, furthermore, the potential of new public education programs for disseminating information and modifying attitudes toward supply and conservation innovations developed in earlier sections of this study. Findings were borrowed from previous research pursuits, including among others, that public receptiveness is maximized with (1) energy policies that reward conservation rather than penalize consumption and (2) policies that are developed as remotely as possible, or "upstream" from the consuming public.

Alternative energy strategies invariably require innovative and frequently untested legal/institutional arrangements for successful implementation. This is particularly true in the case of Riverside because of its committment to diversification of its energy supply system and to the implementation of a variety of innovative conservation activities. Some of the many legal/institutional issues which were raised and examined included.

- Feasible financing, ownership and operational arrangements for developing a small-scale waste-to-energy system
- Legal/political constraints on contractual arrangements between Riverside and neighboring municipalities in financing alternative energy systems
- The legal constraints at the municipal level to the adoption of tax incentives for the installation of solar systems in residences
- Legal uncertainties concerning the infringement of individual property rights associated with a solar-based zoning ordinance
- Conformance of proposed building and/or zoning regulations with existing state legislation.

Each consideration and alternate energy supply option was evaluated in view of these criteria in order to narrow the set of recommended options to those most feasible for implementation.

The objective of investigating technological constraints was to identify those options where significant additional research and development are required and to estimate the time and technological improvements necessary before implementation. The state of technology of the various conservation and supply options will have direct bearing on their feasibility of implementation. For instance, some options, such as photovoltaics and fuel cells, will require some research and development before commercialization. However, other portions, such as flat-plate solar collectors or passive solar design techniques, are commercially available and, therefore, do not require additional research prior to implementation although some further cost and feasibility analysis may be required.

The public and private sector costs of the various conservation and supply options identified were evaluated to estimate their impact on the feasibility of implementation. For instance, California has recently enacted a 55 percent tax rebate on solar heating systems to stimulate their use. Despite the benefits of solar energy, e.g., nonpolluting and nonreliance on scarce fuels, a subsidy or other type of incentive is required to overcome the high capital outlay required of the homeowner in the installation of an active solar system and the dubious cost effectiveness of active solar heating systems compated to conventional natural gas heating systems. The need for such a stimulus impedes the feasibility of implementation. However, active solar heating systems can be implemented on a small scale, in piecemeal fashion, which enhances the feasibility of implementation. On the other hand, large projects, e.g., mass transit systems and central conversion facilities making synthetic fuels from refuse and coal, require substantial blocks of investment capital which may not be readily obtainable.

IMPACT OF RECOMMENDED ENERGY STRATEGIES IN RIVERSIDE

The primary outcomes, secondary outcomes, and feasibility issues relating specifically to the options being evaluated are discussed as follows.

Primary Outcomes

Energy Savings. Tables 41, 42, and 43 show the energy savings estimated for selected conservation and alternative energy supply options based on low, moderate, and high impact assumptions for low, moderate, and high population growth rates in the year 2000.

In each table, the first column lists the conservation and supply options. The second column lists the energy savings based on the various impact assumptions.*

Effect on Emissions. The change in emissions are also shown in Tables 41, 42, and 43 for selected conservation and alternative supply options for the low, moderate, and high population growth rates, respectively, in the year 2000. Columns three through seven of the tables lists the change in emissions for hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulates, respectively, based upon the energy savings and the attendant emissions in pounds per million Btu of fuel. Factors for the latter are given in Table 40.

Although the primary outcomes shown in Tables 41, 42, and 43 are key elements for Riverside's energy planning, they are not the whole story.

Secondary Outcomes and Feasibility

The secondary impacts and the feasibility of implementing energy conservation options and alternative energy supply options must be considered in developing a final energy plan. Secondary outcomes and feasibility are discussed as follows.

Building Retrofit. Retrofitting existing buildings in Riverside represents one of the most energy conserving but marginally feasible options. Its potential for displacing scarce fuels is substantial, but public acceptance stands as a formidable obstacle.

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* For impact assumptions and calculations see Volume 2, Appendix C1, Attachment C1-1; Appendix C2, Attachment C2-2, Appendix C3, Attachment C3-1; Appendix C4, Attachment C4-1; Volume 3, Appendix D.

TABLE 41. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS IN TERMS OF LOW POPULATION GROWTH RATE IN THE YEAR 2000

	Energy Savings		Environmental Impact (Decrease in Emissions, lb x 10^3/yr)				
Options	Impact	Savings	HC	CO	NO_x	SO_2	Particulates
		(BTU's x 10^{12})					
Building Retrofit Code	Low	.660 (a)	4.3	8.3	152.3	86.6	10.3
	Moderate	.923 (a)	6.1	11.5	212.6	120.9	14.4
	High	1.186 (a)	7.8	14.9	272.0	154.4	18.4
State Energy Code	Low	.187 (a)	1.2	2.6	41.4	23.0	2.8
	Moderate	.333 (a)	2.1	4.8	70.5	38.6	4.8
	High	.508 (a)	3.8	7.5	132.7	74.9	9.0
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable		–	–	–	–	–
Modified Housing Mix	Low	.013 (b)	.11	.26	4.8	2.7	.33
	Moderate	.044 (b)	.47	.89	16.1	9.2	1.1
	High	.08 (b)	.84	1.6	29.5	16.7	2.0
Energy-Efficient Neighborhood Development	High Only	.321 (b)	192.6	2535.9	417.3	16.1	41.7
Planning Poilicy to Encourage Use of Passive Solar Building	No Direct Savings Attributable		–	–	–	–	–
Passive Solar Thermal Standard	Low	.141 (b)	.494	4.230	13.677	.085	.846
	Moderate	.231 (b)	.809	6.930	22.407	.139	1.386
	High	.266 (b)	.931	7.980	25.802	.160	1.596
Passive Solar Cooling Standard	Low	.126 (b)	2.268	.044	80.64	52.668	5.544
	Moderate	.187 (b)	3.366	.065	119.68	78.166	8.228
	High	.286 (b)	5.148	.100	183.04	119.548	12.584
Convert Incandescent Lights to High Pressure Sodium	Low	.014 (b)	.50	.01	17.9	11.7	1.2
	Moderate	.014 (b)	.50	.01	17.9	11.7	1.2
	High	.014 (b)	.50	.01	17.9	11.7	1.2
Reduce Total Energy Demand in Street Lighting	Low	.033 (b)	.594	.012	21.12	13.794	1.452
	Moderate	.038 (b)	.684	.013	24.32	15.884	1.672
	High	.105 (b)	1.89	.037	67.2	43.89	4.62
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.533 (c)	.533	2.132	94.341	99.671	4.797
	Moderate	.791 (c)	.791	3.164	506.240	147.917	7.119
	High	1.045 (c)	1.045	4.18	184.965	195.415	9.405
Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.696 (d)	417.6	5498.4	904.8	34.8	90.5
	Moderate	1.043 (d)	625.8	8239.7	1355.9	52.2	135.6
	High	1.393 (d)	835.8	11004.7	1810.9	69.7	181.1
Integrated Utility System Based on Gasification of Coal and Refuse	Low	5.9 (e)	100.	-65.	1600.	600.	65.
	Moderate	7.2 (e)	120.	-80.	2000.	800.	80.
	High	8.7 (e)	150.	-100.	2500.	1000.	100.
Solar Water and Space Heating	Low	0.8 (f)	2.8	28.	78.	0.5	4.8
	Moderate	1.0 (f)	3.5	35.	98.	0.6	6.0
	High	1.9 (f)	6.6	66.	186.	1.1	11.4
Geothermal District Heating	Low	1.9 (g)	51.	39.	184.	1.1	11.
	Moderate	2.3 (g)	62.	48.	224.	1.4	14.
	High	2.8 (g)	76.	58.	273.	1.7	17.
Methane From Wastes	All	0.2 (h)	Essentially No Change				
Remote Generator	All	14.3 (i)	257.	5.	9152.	6000.	630.
Hydrogen Vehicles	All	0.21 (j)	126.	1659.	273.	10.5	27.3

For assumptions and detailed calculations, see

(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

TABLE 42. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS IN TERMS OF MODERATE POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings Impact	Energy Savings Savings (BTU's x 10^{12})		Environmental Impact (Decrease in Emissions, lb x 10^3/yr) HC	CO	NO_x	SO_2	Particulates
Building Retrofit Code	Low	.660	(a)	4.3	8.3	152.3	86.6	10.3
	Moderate	.923	(a)	6.1	11.5	212.6	120.9	14.4
	High	1.186	(a)	7.8	14.9	272.0	154.4	18.4
State Energy Code	Low	.283	(a)	1.8	4.1	63.7	35.2	4.3
	Moderate	.476	(a)	2.9	7.1	101.5	55.3	6.9
	High	.715	(a)	4.4	10.5	153.3	83.8	10.4
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable			–	–	–	–	–
Modified Housing Mix	Low	.025	(b)	.26	.5	9.2	5.2	.63
	Moderate	.079	(b)	.83	1.6	29.1	16.5	2.0
	High	.142	(b)	1.5	2.8	52.3	29.7	3.6
Energy-Efficient Neighborhood Development	High Only	.573	(b)	343.8	4526.7	744.9	28.7	74.5
Planning Policy to Encourage Use of Passive Solar Building	No Direct Savings Attributable			–	–	–	–	–
Passive Solar Thermal Standard	Low	.252	(b)	.882	7.560	24.444	.151	1.512
	Moderate	.412	(b)	1.442	12.360	39.964	.247	2.472
	High	.475	(b)	1.663	14.250	46.075	.285	2.850
Passive Solar Cooling Standard	Low	.187	(b)	3.4	.065	119.7	78.2	8.2
	Moderate	.293	(b)	5.3	.103	187.5	122.5	12.9
	High	.393	(b)	7.1	.138	251.5	164.3	17.3
Convert Incandescent Lights to High Pressure Sodium	Low	.014	(b)	.50	.01	17.9	11.7	1.2
	Moderate	.014	(b)	.50	.01	17.9	11.7	1.2
	High	.014	(b)	.50	.01	17.9	11.7	1.2
Reduce Total Energy Demand in Street Lighting	Low	.038	(b)	.68	.013	24.3	15.9	1.7
	Moderate	.076	(b)	1.37	.03	48.6	31.8	3.3
	High	.114	(b)	2.05	.04	72.9	47.7	5.0
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.627	(c)	.63	2.5	110.9	117.3	5.6
	Moderate	.927	(c)	.93	3.7	164.1	173.4	8.3
	High	1.223	(c)	1.22	4.9	216.5	228.7	11.0
Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.801	(d)	480.6	6327.9	1041.3	40.1	104.1
	Moderate	1.202	(d)	721.2	9495.8	1562.6	60.1	156.3
	High	1.603	(d)	961.8	12663.7	2083.9	80.2	208.4
Integrated Utility System Based on Gasification of Coal and Refuse	Low	7.2	(e)	120.	-80.	2000.	800.	80.
	Moderate	8.7	(e)	150.	-100.	2500.	1000.	100.
	High	10.5	(e)	180.	-120.	3000.	1200.	120.
Solar Water and Space Heating	Low	1.0	(f)	3.5	35.	98.	0.6	6.0
	Moderate	1.2	(f)	4.2	42.	118.	0.7	7.2
	High	2.0	(f)	6.7	67.	188.	1.1	11.5
Geothermal District Heating	Low	2.3	(g)	62.	48.	224.	1.4	14.
	Moderate	2.8	(g)	76.	58.	273.	1.7	17.
	High	3.4	(g)	93.	71.	333.	2.1	21.
Methane From Wastes	All	0.2	(h)	Essentially No Change				
Remote Generation	All	14.3	(i)	257.	5.	9152.	6000.	630.
Hydrogen Vehicles	All	0.24	(j)	144.	1896.	312.	12.	31.2

For assumptions and detailed calculations, see
(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

TABLE 43. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS IN TERMS OF HIGH POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings			Environmental Impact (Decrease in Emissions, lb x 10^3/yr)				
	Impact	Savings		HC	CO	NO_x	SO_2	Particulates
		(BTU's x 10^{12})						
Building Retrofit Code	Low	.660	(a)	4.3	8.3	152.3	86.6	10.3
	Moderate	.923	(a)	6.1	11.5	212.6	120.9	14.4
	High	1.186	(a)	7.8	14.9	272.0	154.4	18.4
State Energy Code	Low	.394	(a)	2.4	5.9	84.8	46.1	5.7
	Moderate	.631	(a)	3.9	9.3	135.7	74.1	9.2
	High	.904	(a)	5.7	12.7	197.7	109.3	13.4
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable			–	–	–	–	–
Modified Housing Mix	Low	.039	(b)	.41	.79	14.4	8.2	.98
	Moderate	.124	(b)	1.3	2.5	45.7	25.9	3.1
	High	.222	(b)	2.3	4.5	81.8	46.5	5.6
Energy-Efficient Neighborhood Development	High Only	.900	(b)	540.0	7110.0	1170.0	45.0	117.0
Planning Policy to Encourage Use of Passive Solar Building	No Direct Savings Attributable			–	–	–	–	–
Passive Solar Thermal Standard	Low	.395	(b)	1.383	11.850	38.315	.237	2.370
	Moderate	.646	(b)	2.261	19.380	62.662	.388	3.876
	High	.745	(b)	2.608	22.350	72.265	.447	4.470
Passive Solar Cooling Standard	Low	.276	(b)	5.0	.097	176.6	115.4	12.1
	Moderate	.416	(b)	7.5	.146	266.2	173.9	18.3
	High	.540	(b)	9.7	.19	345.6	225.7	23.8
Convert Incandescent Lights to High Pressure Sodium	Low	.014	(b)	.50	.01	17.9	11.7	1.2
	Moderate	.014	(b)	.50	.01	17.9	11.7	1.2
	High	.014	(b)	.50	.01	17.9	11.7	1.2
Reduce Total Energy Demand in Street Lighting	Low	.045	(b)	.81	.016	28.8	18.8	1.98
	Moderate	.089	(b)	1.60	.031	56.9	37.2	3.9
	High	.134	(b)	2.41	.047	85.8	56.0	5.9
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.740	(c)	.74	2.96	131.0	138.4	6.7
	Moderate	1.095	(c)	1.09	4.38	193.8	204.8	9.9
	High	1.443	(c)	1.44	5.77	255.4	269.8	13.0
Education Program on Vanpooling/Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.939	(d)	563.4	7418.1	1220.7	47.0	122.1
	Moderate	1.408	(d)	844.8	11123.2	1830.4	70.4	183.0
	High	1.878	(d)	1126.8	14836.2	2441.4	93.9	244.1
Integrated Utility System Based on Gasification of Coal and Refuse	Low	8.7	(e)	150.	-100.	2500.	1000.	100.
	Moderate	10.5	(e)	180.	-120.	3000.	1200.	120.
	High	12.8	(e)	200.	-140.	3700.	1600.	150.
Solar Water and Space Heating	Low	1.3	(f)	4.6	46.	127.	0.8	8.
	Moderate	1.3	(f)	4.6	46.	127.	0.8	8.
	High	2.2	(f)	7.7	77.	216.	1.3	13.
Geothermal District Heating	Low	2.8	(g)	76.	58.	273.	1.7	17.
	Moderate	3.4	(g)	93.	71.	333.	2.1	21.
	High	4.1	(g)	113.	87.	406.	2.6	26.
Methane From Wastes	All	0.2	(h)	Essentially No Change				
Remote Generation	All	14.3	(i)	257.	5.	9152.	6000.	630.
Hydrogen Vehicles	All	0.38	(j)	228.	3002.	494.	19.	49.

For assumptions and detailed calculations, see
(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

To a large degree, the public response to the effectiveness of a retrofit program is dependent upon the implementation mechanism selected by the Riverside community. Three basic types of options are available, each of which will produce widely different outcomes.

Public Education Programs: Aimed at increasing public awareness of the potential payoffs of various retrofit actions, this program could be administered by the Planning Department and include handbooks and on-site technical assistance. Outcome: no significant adverse public response; limited success, assuming moderate price increases in conventional fuels.

Incentive Programs: Locally designed and administered programs aimed at inducing investment in building retrofit. Although California state law permits municipalities no authority to modify local tax structures, other incentive schemes mav be devised. CETA workers, for example, could be employed to perform the necessary tasks, with homeowners providing only the necessary materials. Outcome: no significant adverse public response: somewhat greater, but still limited, adoption of incentives, again assuming moderate price increases in conventional fuels.

Enactment of a Building Retrofit Code: This amounts to a locally mandated retrofit program to achieve specified standards of energy conservation in buildings. The code may assume the form of materials standards (e.g., insulation, glazing, etc.) or performance standards e.g., (Btu's consumed per square foot of floor space). Conformance could be mandated within a specific time frame or at the time of property transfers; the first, of course, would result in more immediate energy savings. Retrofit costs would be absorbed primarily by the property owner, although complementary support such as the CETA program described above facilitate implementation of such a retrofit code. Outcome: major adverse response to costs incurred for retrofit; major energy savings would accrue, the exact volume of which would depend upon the time frame mandated in the code and difficulties encountered in the implementation process. Enactment of a building retrofit code would represent national landmark action in municipal involvement in energy conservation efforts.

Optimum Administration of State Energy Code. Administration of the new State energy code for new residential and nonresidential buildings rests squarely with Riverside city government. Adequate administration will depend on the number and skills of building inspectors within the City's Building Division. The State Energy Commission is expected to provide the necessary orientation for building inspectors in order to minimize the start-up time associated with the enactment of the new code. From a public acceptance standpoint, the reconciliation of conflicting interests presumably was at least partially achieved during deliberations prior to enactment of the code. Unlike other conservation actions, implementation is not a local option; it is a legal responsibility. Public displeasure stemming from the costs of conformance are a moot issue from Riverside's standpoint, though occasional code violations are likely to occur during the first years of enforcement. Lingering distaste among architects, builders and contractors may translate into a degree of nonconformance which will escape building inspectors unfamiliar with the requirements of the code.(95)

Modified Housing Mix. The feasibility of this option is largely dependent upon the spacing and timing of new multifamily housing units. In large undeveloped areas earmarked for housing development, rezoning for multifamily use would probably encounter little resistance since owners of existing single family units will not be directly affected. Higher density developments in large undeveloped tracts generally will not be perceived as infringements on the existing environment within built-up areas.

In areas zoned for single-family residences, in which few parcels remain, rezoning to permit multifamily units will probably encounter opposition from existing residents. A homeowner buys into a neighborhood with the expectation that its existing characteristics will remain approximately intact for as long as he/she retains property in that area. Rezonings for any purpose which signify a fundamental alteration of a neighborhood environment typically encounter local opposition, particularly in the case of multi-family or institutional extensions in single-family neighborhoods. If, however, such developments are spatially dispersed and individual developments are limited in scale, the probability of public resistance is commensurately reduced. These limitations appear to be especially applicable in Riverside where sentiments in favor of single-family housing are deeply ingrained. In any case, some delay in implementation will occur as a result of the necessary hearings that accompany rezoning.

Energy-Efficient Neighborhood Development. Significant energy conservation can be achieved in Riverside through more explicit consideration of the transportation costs associated with alternative neighborhood design concepts. Underlying each conservation-oriented design is the assumption that both trip length and trip numbers can be reduced by planning and zoning approaches that minimize the length and frequency of shopping, recreational and journey-to-work trips. Depending upon the specific plan, reductions of 15 to 50 percent of both types can be expected. Insofar as revisions in the existing zoning codes will be necessary, some degree of builder opposition can be expected. The inclusion of neighborhood shopping centers and neighborhood parks in tract development plans may create unwelcome additional costs to builders; However, it is anticipated that these will be minimal.

Of greater economic significance to the builder is the possibility of stricter regulations on "leap frogging", that is, residential development in areas zoned for such use but noncontiguous with existing developments. Controls of this type invariably result in higher land costs to the developer but, on the other hand, are less burdensome to the municipality in terms of public service provision. In general, leap frogging is not expected to be a major problem in view of the current planning effort for Arlington Heights. This will result in some form of phased development in the city's most extensive parcel of undeveloped land.

Passive Solar Building Design (Orientation). Efforts to impose controls on the orientation, materials and setback distance of new structures may result in builder and/or consumer opposition. Since all three measures represent departures from the conventional forms of zoning and building codes, builder and homeowner resistance is likely to surface. Opposition will likely stem from those who simply prefer to minimize all forms of governmental interface in private decision making as well as those concerned with the perceived cost increases associated with mandated passive design. For example, orienting all new tract developments in the north-south direction (to maximize southern exposure) may create additional grading costs. Similarly, the use of non-conventional structural materials and the construction of double walls will create additional costs through both materials acquisition and (possibly) installation. Although such costs will be passed on to home buyers, builders will be burdened by dealing with unfamiliar materials and techniques. Life cycle costs over a period of time will be lower for the homeowner.

The most appropriate implementation mechanism for the various, passive design concepts discussed earlier is a solar-based zoning ordinance. Such an ordinance may take the form of modifications to the existing zoning code or alternatively, a separate ordinance that deals exclusively with solar-related design considerations. While either may achieve the goals of furthering energy conservation through passive design, an ordinance specific to solar considerations would provide both public awareness advantages as well as a reduction in some of the legal uncertainties surrounding solar rights in California.

Passive Solar Thermal Design Standard. From a technological standpoint, passive design standards and performance predictability are still in their infancy. The thermal properties of many construction materials are still in the evaluation stage, and new construction materials research, though widespread, has yet to produce definite answers for design in different physical environments.

Passive Solar Cooling Design Standard. New building shielding/shading regulations will raise many of the same public reactions as passive thermal design measures; objections to further governmental regulation of land development and specifically, increased costs associated with shade plantings. The most vocal reactions will likely come from owners of existing properties, should the regulations affect their (in addition to new) dwelling units. This is anticipated because the incremental cost of new units attributable to shading regulations will be far less conspicuous (i.e., hidden) than costs that accrue to existing properties. As in the case of numerous other conservation measures, however, the really substantial energy savings will result only if existing dwelling units are included. In contrast to other passive conservation measures, no major technological uncertainties are associated with shading regulations; the choice of appropriate shade trees is limited to a few varieties that demonstrate the necessary foliage characteristics and environmental adaptability for the Riverside area.

Conversion to Energy-Efficient Street Lamps and Reduction in Overall Levels of Street Lighting. Both more efficient street lamps and a reduction in the overall levels of lighting offer immediate energy savings. Conversion of existing incandescent lamps to high pressure sodium and reduction in the lighting level of all or a select number of lamps are the means by which such savings will be realized.

Neither option is expected to encounter major public opposition or legal institutional obstacles. Only in the case of reductions in the lighting level is some public displeasure likely to occur. However, this may be minimized if such reductions are (1) gradually and (2) uniformly implemented. By avoiding the peaks and troughs of light created by reducing every second or third lamp, the real and perceived diminution of personal security will be minimal. Some Federal/state regulations pertinent to the proposed lighting standards do not apply to municipally controlled streets; thus, no legal problems are anticipated.

Improvement in Efficiency of Industrial Processes and Operations. Industry will tend to adopt energy saving techniques automatically as energy prices increase since energy cost impacts directly on product costs and profits. The large amount of relatively small and diversified industry in Riverside may need encouragement and help in locating effective energy conservation measures for their particular situation. There is a large amount of technical information available, and the proposed Riverside Energy Coordinator and educational program should serve to make the needed information available. Large industry already has effective energy conservation programs and are expected to continue their efforts.

Reduction in Vehicle Size, Van/Car Pooling, Increased Use of RTA Buses, Driving Efficiencies. Use of the private automobile is so heavily ingrained California's and Riverside's lifestyle that no significant changes are foreseen by the year 2000. Programs on reduced vehicle size, van/car pooling, increased use of RTA buses, and bike routes are already well publicized, and can be made more intensive and locally targeted by the recommended Riverside Energy Coordinator. Smaller, more efficient vehicles will be automatically adopted as the Federal regulations on new automobile efficiency affects an increasing portion of all vehicles to the year 2000. California is already leading the nation in use of smaller vehicles.

The problem with the increased use of buses or car/van pools is the dispersed nature of most trips in Riverside. Also, a significant portion of Riverside driving is toward various points outside the community.

More detailed information is needed on the specific travel patterns of Riverside citizens. This should be done as a first step in evaluating just what the possibilities are for increasing the number of persons per vehicle or changing the mode of travel.

Solar Water and Space Heating. Solar energy systems are by far the most discussed alternative fuel in California's energy future. The feasibility of achieving the three levels of solar implementation presented in this study are dependent on two critical variables, (1) the cost of alternatives through the year 2000, and (2) public awareness and reaction to solar versus conventional energy costs. Using the economic input parameters assumed in this study, it was concluded that solar hot water and space heating are presently competitive with other forms of heating available to Riverside residents and especially to those residents who utilize electric resistance heating. In these cases, savings of $6,000 (1978 dollars) over a 20-year life can be realized. For gas-heated homes, however, only $200 savings is possible, thus making solar heating only marginally cost effective compared to gas.

"Rational" public response to such life-cycle costs, however, is by no means automatic. Initial capital outlay for both new and retrofit systems represents a substantial investment for even middle-income families.* Although Bank of America provides loans for solar systems, other lending institutions remain cautious in approving solar energy system loans, and the 55 percent income tax credit provides no immediate relief for the potential investor.

The brief history of solar incentives in California reveals some preliminary insights into the effectiveness of such incentives. The original 10 percent credit (or $1000, whichever is the lesser) enacted in 1976 produced 5434 claims out of 8 million tax returns.[(94)] In 1977, the limit was raised to 55 percent, with a $3000 limit, and the response has not yet been compiled by the State Department of Taxation. However, the state estimates at least a four-fold increase in the number of claims. With a subsidy of this magnitude, such a response would still be of fairly modest proportions. If the income tax credit were supplemented by a property tax exemption, solar-based zoning ordinance and/or a program to offset installation costs, the diffusion of solar systems would be commensurately hastened.

<u>Integrated Utility System (IUS)</u>. A decision to construct a refuse-fired and coal IUS would necessitate a long-term, large-scale commitment by the Riverside Community. Short-term disruptions caused by piping installations and obligations incurred by long-term bond financing are two examples of the far-reaching ramifications of an IUS serving portions of the built-up areas of the City. In the following discussion, two existing central heating plants where refuse is the primary fuel were examined to identify the most commonly encountered legal/institutional and environmental ramifications of such projects. This is followed by a review of a number of proposed California projects, and the opportunities for organizing and financing a Riverside waste recovery system in the near future.

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* If the tax reductions resulting from Proposition 13 are not replaced by user fees and changes of an equal magnitude, homeowners may be more disposed to making investments in active solar energy systems. This would be especially true if property tax exemption were enacted.

Nashville. The Nashville experience stands as a precedent setting example of state support for a municipal waste-to-energy system. The Nashville Thermal Transfer Corporation is a public enterprise created in 1970 under provisions of the Tennessee General Corporation Act.[95] The Corporation was formed for the exclusive purpose of providing low-cost district heating and cooling for about two dozen office buildings in the Nashville CBD. The facility and its distribution system were financed and constructed on behalf of the Metropolitan Government of Nashville and Davidson County. The initial $16.5 million bond issue for construction was issued in 1972, followed by a state loan of $5.7 million and additional junior lien bonds for $2.5 million, both in 1976. The plant's rated capacity is 720 tons/day for its two refuse burning boilers; backup energy is provided by a single oil-burning boiler. All three boilers commenced operation in 1974. In the first two years of operation, numerous technical and financial problems prevented the plant from achieving its full generation potential. These included: excessive particulate emissions and an EPA Compliance Order in 1975; unexpected high maintenance costs for the incinerator boilers and emission control equipment; and the escalated cost of oil and gas to operate one boiler. These and other costs forced the Corporation to seek an additional $8 million in long-term financing over and above the initial $16.5 million bond issue. In FY 1975-1976, the Corporation's operating revenues totaled $2.9 million.

The operation of the refuse-to-energy heating and cooling system is closely linked to the METRO government in three key areas. First, the Corporation's contract with the city includes an option to receive all refuse from METRO. Second, METRO provides an annual payment to the Corporation in an amount not to exceed $1.5 million in order to assist the Corporation in meeting its long-term debt. Third, among the eleven-member Board of Directors, five are appointed by the Mayor of METRO and two are office holders on the METRO County Council. The Corporation, therefore, closely resembles a municipal corporation: its financial, technical and administrative operations are closely tied to the METRO government.

Saugus, Massachusetts. In contrast to the Nashville plant, the Saugus waste recovery system is a private sector venture contractually linked to 16 Massachusetts municipalities that provide approximately 1200 tons per day of refuse.[96] The plant is jointly owned by the designer, Wheelabrator-Frye, Inc., and the builder, M. DeMatteo Construction Co., who together established the Refuse Energy Systems Company (RESCO). The Saugus plant is the outgrowth of a number of circumstances which collectively created a near ideal environment for construction of the facility:

- A privately owned landfill nearing capacity and generating severe adverse environmental impact
- A high density urbanized area with no additional viable landfill sites
- A nearby industrial customer (General Electric) in need of a large stable supply of steam.

After lengthy negotiations between the muncipalities, producers and consumers, and an in-depth technical/economic report by an independent consultant, contractual arrangement was finalized in 1975. The contract includes provisions that insure the delivery of refuse by the consortium of municipalities and the sale of steam to General Electric's River Works Plant in Lynn, Massachusetts. The plant offered a simultaneous long-term private sector solution to landfill shortages, adverse environmental impacts, and the energy requirements of a large industrial consumer. Replicability of the Saugus experience would appear to be most promising in a high density, heavily industrialized urban area confronted with both severe land constraints and heavy dependence on scarce fossil fuels.

The California Environment. With the enactment of SB 1395 (1976) California formalized its support for large-scale waste recovery projects throughout the State. The Bill, as finally passed, required state support or at least one energy or materials recovery site by the Solid Waste Management Board (SWMB). The Act reflects the State's recognition of the special role of waste recovery systems in overall energy planning. Such projects are becoming increasingly attractive as oil and gas prices continue to rise and, equally important, as new landfill sites near major urban centers in California become increasingly scarce and costly. With the exhaustion of Riverside's current landfill capacity in the near future, waste recovery is an increasingly viable alternative which, if properly conceived, would probably be eligible for some form of state support.

The current SWMB recommendation calls for State support of six waste recovery projects with an appropriation of $66,250,000 according to the following:[97]

- $6 million for prebonding activities
- $20 million for the establishment of a Joint Revenue Support Fund
- $40 million for the establishment of a Supplementary Environmental Protection Fund
- $250,000 for a study of ash residue classification.

It is anticipated that the $60 million in both the Joint Revenue and Environmental Funds will <u>not</u> be expended; they are intended to insure investors that a project will repay its debt (Revenue Support Fund) and have available adequate financing to pay for additional environmental protection equipment necessary to operate a plant once it is constructed (the Environmental Protection Fund). Both are viewed as measures to create more favorable interest rates for the jurisdictions that issued bonds to finance the waste recovery projects.

In Table 44, the proposed Riverside district heating plant is compared, in terms of capacity, product and other characteristics to the six plants selected by the SWMB for initial state support. All involve some form of public and private sector cooperation in the processing, energy conversion, distribution and consumption components of the plants. Project capacities range from over 0.5 million tons per year of waste in Humboldt County (2)* and San Francisco to 290,000 tons per year in Humboldt County (1).* Project capacity among electricity-producing projects ranges from 8.5 MW to 40 MW; San Diego ranks first among the two steam producers with 244,000 pounds per hour at 850 psig and 800°F. All projects are expected to generate 40 to 60 permanent jobs, and an unspecified number of temporary jobs during construction. Capital costs range from $27 million for Humboldt County to $89 million in San Diego. Finally, ferrous recovery is an integral part of the design and financial planning of all projects. Estimates range from 7,300 to 26,000 tons per year.

If all projects are implemented, capital costs will total approximately $400 million. Most of this amount probably would be financed with tax-exempt municipal bonds which, under California law, may be issued by cities, counties, special districts, joint power agreements, and the State. In cases where a private enterprise is involved, the California Pollution Control Financing Authority (CPCFA) is authorized to issue tax-exempt lease-revenue bonds** on behalf of that enterprise. The SWMB has recommended that existing bonding limitations on the CPCFA be eased for this purpose. If Riverside should elect to implement its district heating system through a joint public private venture, this exemption device might be utilized.

Under relatively favorable market conditions, the SWMB estimates the following bond yields:

Local revenue bonds: 6.0-6.75%

Local general operating bonds: 5.25-5.50%

State revenue bonds: 5.50-6.25%

State general operating bonds: 4.50-5.25%

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* Reference to first column of Table 44.

** Security for lease revenue bonds is dependent upon the lease payment stream established by contractual agreements, possibly independent of project revenues.

TABLE 44. MAJOR CHARACTERISTICS OF SIX REFUSE TO ENERGY PROJECTS SELECTED FOR FINANCIAL SUPPORT BY THE CALIFORNIA SOLID WASTE MANAGEMENT BOARD COMPARED TO PROPOSED RIVERSIDE PLANT

Sponsor	Purpose	Capacity (tons/year)	Energy Product	Permanent Employment	Capital Costs ($ millions)	Ferrous Recovery (tons/year)
City of Alameda	Municipal waste disposal, electricity	329,000	28 MW	40	71	25,000
County of Contra Costa	Municipal waste and sludge disposal, energy for sewage treatment	365,000 (waste and sludge)	8.5 MW, 80,000 bbl/yr combustion fuel	50	43	20,000
Humboldt County (1) Initial Proposal	Municipal and wood waste disposal, electricity	290,000	19 MW	50	27	7,300
or						
Humboldt County (2) Humboldt Bay Power Co. Proposal	Municipal and wood waste disposal, electricity	550,000	40 MW, 580,000 bbl/yr fuel oil	60	45	7,300
County Sanitation Districts of Los Angeles and Long Beach	Municipal waste disposal and Industrial steam	329,000	170,000 lb/hr @ 500 psig/650° F	60	70	13,000
City of San Diego	Municipal waste disposal, electricity, industrial steam	373,000	244,000 lb/hr @ 850 psig/200° F	60	89	19,000
City & County of San Francisco and Sanitary Fill Company	Municipal waste disposal, electricity	511,000	34 MW	50	80	26,000
Riverside	industrial steam	150,000	250 psig		23	

Source: California State Solid Waste Management Board, Refuse to Energy Conversion Projects, March, 1978.

These figures, and especially the differential between state and local bonds, are highly sensitive to changing conditions in the bond market associated with changing economics trends and legislative action and initiatives, the most dramatic example of which is the recent passage of Proposition 13.

In summary, State support for an energy recovery plant in Riverside would appear to be a strong possibility in the near future. The potential contribution of such projects to California's energy future has been recognized for two years and financial support in various forms will probably be available over the next decade. Although some novel contractual arrangements for financing, ownership, and operation of the Riverside plant may be necessary, the cumulative experience of other California cities over the next few years will provide valuable guidance to insuring viable project planning in Riverside. At this point, it appears that environmental rather than legal/institutional constraints will be the major obstacles to the implementation of a waste recovery plant in the Riverside community.

Methane Recovery. Public acceptance poses no serious obstacles to methane recovery from the Riverside landfill. The well digging, piping system, purification and pipeline injection all occur at or very near the existing landfill without major environmental consequence. The gas derived from the project would reach the Riverside consumer completely mixed with natural gas imported through the existing distribution system.

The major feasibility issues center on institutional and technological uncertainties. Without the willingness of Southern California Gas (SCG) to purchase the methane, the recovery project will lack the necessary contractual guarantees between the recovery and pipeline injection. A private contractor must agree to purchase the gas and upgrade it through purification in order to insure salability. In the case of the Palos Verde Landfill, Reserve Synthetic Fuel, Incorporated (RSF)[98] operates the purification plant on site, processing approximately two million cubic feet daily for injection into a nearby SCG pipeline. However, numerous operational problems during the past one and a half years have shut down the plant. FSF has overcome most of the problems; however, they are proceding with an additional site at Monterey Park. Nevertheless, the technological feasibility of the Palos Verdes, Riverside, or any other methane recovery scheme is dependent upon the depth (approximately 100 feet minimum) and composition (methane content) of the site. Either/or both of these constraints could impede the implementation process in Riverside.

Geothermal/Wind. The geothermal and wind options present no major public acceptance problems. Although some objection to environmental impacts are likely--such as water and air pollutants from geothermal sources and aesthetic intrusions from centralized wind power--few are likely to originate in the Riverside community because of the remoteness of both developments. However, capital requirements, electric power transmission contracts, and technological uncertainties all pose potentially serious impediments to implementation. In the following discussion, a number of the more critical questions are examined for the case of geothermal development.

Private/Public Sector Cooperation. In view of the technological complexity and capital requirements of geothermal development, it is probable that Riverside will have to seek some form of joint venture with other utilities to successfully develop available geothermal resources. This will be true in the cases of all the most attractive resource areas, including Coso Hot Springs, Brawley, Heber, and Arrowhead Springs. All these sites are either undeveloped or in their initial stage of development.

Electrical Applications. For electrical production, transmission of the power to the City remains the most difficult problem. Whereas, a precedent exists for joint ownership of geothermal wells in the Geysers, and for nuclear and coal developments in California and Utah, the specific question of transmitting geothermally derived electricity in the South Coast area has not been addressed. Currently no direct electric transmission services exist between the Imperial Valley and Riverside. Transmission lines could be constructed, however, construction of new transmission lines would be both costly and environmentally objectionable. The logical potion is for Riverside to utilize existing utility line with excess capacity and to finance the cost of additional line to complete the interconnections necessary to receive power in Riverside's existing grid. Riverside currently has an agreement for wheeling rights over Southern California Edison's 220 kilo volt transmission network.

In addition to the transmission problem, system reliability and backup poses a second major institutional uncertainty. Geothermal energy is still a relatively new energy source for electrical generation. It is not unreasonable to assume that over the next 20 years, Riverside, or any other community or utility, will be compelled to provide backup power during and following the development of its geothermal potential. SCE, as the major source of electricity in Riverside, is the logical source of such power.

Nonelectric Applications. For nonelectric applications of geothermal energy, different barriers to development may be identified. First, development of the Arrowhead resource will require a major prior commitment on Riverside's part to buy steam, a step which few consumers are likely to take given the technological and economic uncertainties surrounding this type of resource development. Because nonelectric application of geothermal energy are confined by distance limitations between the source and consumer, Riverside would probably have to invest in the very early stages of proving the resource. This, however, will require risk capital that the City is unlikely to raise given current fiscal constraints.

Environmental issues will also pose serious obstacles to geothermal development. The siting of wells and transmission facilities, waste disposal, and subsidence all represent potentially serious obstacles to geothermal development in Riverside. Neither San Bernardino nor Riverside Counties have well-developed procedures for issuing exploration permits. The wide policy variations across counties which have been involved in development indicate that the local political environment is perhaps the single most important determinant of a county's regulatory behavior.(99) In effect, this means a substantial degree of unpredictability in future county involvement in geothermal development. This uncertainty is compounded by the still evolving geothermal siting regulations under development by the Energy Commission. Even when these two actors have clearly defined their roles and procedures, individual plans will be scrutinized by the regional Water Quality Control Board and the Department of Oil and Gas for, respectively, surface water impacts and subterranean impacts of all types.

Because of the potentially diffuse nature of geothermal exploitation for nonelectrical purposes, a multitude of individual projects and the attendant permit-granting and environmental review processes may create serious obstacles to the timely development of these resources.

Issues Specific to the Imperial Valley. In addition to the aforementioned general feasibility issues, several constraints on geothermal development specific to the Imperial Valley are worthy of mention.

First, the Department of the Interior and the California Department of Fish and Game have identified five endangered species. Although this issue has not been raised during the initial stages of resource development in recent years, environmentalists undoubtedly will do so as the pace of exploration and development quickens. A recent Supreme Court decision concerning a Tennessee dam suggests that no endangered specie is too insignificant to legally ignore in the construction of public or private works.

Second, owners of the Imperial Valley's rich agricultural resources probably will not be willing to sacrifice their landholdings for geothermal development. Such conflicts, of course, depend entirely upon the specific sites preferred by the developers. The potential would appear substantial, however, since a 100 MW plant would occupy approximately 20 acres of land, and smaller capacity units may be necessary depending on the energy density of the resources. The incentive to build units less than 50 MW in order to escape the Energy Commission's jurisdiction further reinforces the likelihood of a dispersed pattern of plants. Additional constraints are introduced by the zoning limitations imposed by the Imperial Valley Current Zoning Plan and Ultimate Land Use Plan.

In summary, numerous environmental and economic interests will emerge during the process of geothermal development in the Imperial Valley. The possibility and timing of Riverside's involvement in this development will depend heavily on the reconciliation of the potential discord among these major actors.

Hydrogen. Hydrogen can be a clean fuel for most applications. It is of particular interest for use as a vehicle fuel and there are many experiments going on relative to using hydrogen as a vehicle fuel. The cost of hydrogen compared to that of petroleum is still not competitive, and there are technical problems to be solved. Public acceptance will be low because of (1) their perception that hydrogen is unsafe and (2) decreased performance and increased costs for their vehicles.

A demonstration using electrolysis produced hydrogen in the Riverside Municipal Fleet is suggested to provide experience in using hydrogen to solve technical problems and overcome public resistance. There appears to be no significant legal or institutional obstacles.

Feedlot Manure. There is a significant amount of feedlot manure around Riverside which gives rise to its use to produce methane. There should not be adverse public reaction. Technology is not yet at an advanced stage. The most significant feasibility problems appear to be industry participation in the production and injection of the gas produced into existing pipelines. Feasibility of the long-term use of this resource will need study.

City Energy Coordinator. The appointment of a City Energy Coordinator will serve as a visible commitment to the community that the City is sensitive to, and planning for, future energy needs. The Coordinator will act to oversee and coordinate energy-related planning across all departments, especially with the Planning, Public Utilities, Public Service, and the Public Works Department. While there are no real legal or institutional obstacles, the establishment of such an office could be perceived by the public as the "tip of the iceberg" toward the establishment of a large and expensive bureaucracy. As a result, there could be public and political opposition if the establishment of such an office is not handled in a manner sensitive to the cost concerns of the public.

Solar-Based Zoning Ordiance. The protection of solar access is one prerequisite to promoting solar technology within the Riverside Community. To date, other California cities, e.g., Palm Springs, Davis, and Santa Clara, have recognized the need for such protection and have proceeded to move in the direction of revised city ordinances. However, numerous legal uncertainties remain and it is likely that court rulings will be necessary to clarify the legality of the various approaches currently under consideration.

Since 1872, the California Civil Code has recognized the right to receive light over another's land if such a right is created under an express agreement. This contractual requirement is tantamount to a solar easement law, comparable examples of which exist in at least seven states: Colorado, Illinois, Kansas, Maryland, New Mexico, North Dakota, and Oregon. In some cases, these statutes have served to reinforce existing easement laws in order to remove uncertainties specific to solar access. California has no such solar easement law at present, although the history of State court actions suggests that an adequate precedent for awarding damages and enjoining obstructions does exist in cases of express agreement between property owners. Both State law and municipal ordinances have provided the legal basis for such decisions.

Such voluntary agreements, however, fall far short of creating a truly propitious environment for the large-scale adoption of solar energy systems. A less cumbersome approach is the revision of local zoning ordinances for the purpose of ensuring solar access to either all property owners or a select group located within designated solar zones.

A first option would involve comprehensive review of the existing ordinance for adequacy in protecting the solar access of all property owners. This would include consideration of set back distances, height restrictions, and landscaping regulations. The ordinance also might be revised to secure a buffer area to protect adjacent properties subject to different height restrictions. These types of revisions would be most necessary in mixed commercial/residential areas where building heights are most variable.

A second option, selected solar protection, would establish solar zones wherein all structures would be constructed according to solar specifications. This amounts to a special zoning ordinance for a subarea(s) of the city for the explicit purpose of promoting solar technology. The advantage to such zones is that no random economic inequities are created as in the case of a comprehensive revision of the City's zoning ordinance. Such a system avoids the introduction of developmental constraints on property owners attributable to zoning restrictions which protect solar access of neighboring properties. Solar zones provide protection for those property owners who voluntarily opt for solar systems; this may be contrasted to mandated constraints on a property owner whether or not he chooses to utilize solar technology.

A third option worth mentioning, and one which has attracted increasing attention in recent years, is the transfer of development rights concept (TDR). TDR assumes that the ownership of land is separable from the right to develop that land in a use different from the existing use. In the present context, this would mean for example, that a property owner wishing to construct a high-rise building next to a residential unit would transfer his "right" to another parcel which would not deprive the adjacent owner of solar access. Development rights, therefore, are marketable independent of the land itself. This permits a reconciliation between the public need for rationale land use regulation and the property owner's right to realizing a parcel's development potential in an equitable manner.

A simple hypothetical example will serve to illustrate the operation of the TDR concept.(101) Assume that two 100-acre vacant parcels, A and B, are ready for development and are zoned for single family use. Variance requests by owners A and B result in permission to construct apartments on parcel A, but require that parcel B remain as open space. Under the city's TDR system, each landowner has been assigned one "development right" for each acre of land. Thus, it behooves the owner of parcel A to purchase B's municipally granted development right(s) (and any other B might own) to accumulate sufficient total rights to develop parcel A for apartment use. By institutionalizing this form of transaction, municipal land use regulations operate without causing "windfall" profits for owner A and "wipeout" losses to owner B. TDR, therefore, offers a neat solution to the inherent inequities of local land use controls by addressing the questions of how, under what circumstances, and in what amounts private owners will be compensated for the adverse effects of public controls.

In the short run, however, implementation of a TDR program within Riverside would create more legal and administrative uncertainties that a more traditional zoning concept would avoid. A solar-based zoning ordinance of the type developed by the City of Santa Clara would provide the essential protection for the vast majority of solar users in the City. The proposed Santa Clara ordinance is comprised of four components.(101) First, the use of solar collectors is permitted within all zones of the City.

Second, the ordinance specifies a procedure for establishing airspace easements among property owners, as well as guarantees of recognition by the City building department. Third, solar access is explicitly recognized as a criterion for granting or refusing zoning variances within an easement area. Finally, the ordinance provides a vehicle for ensuring that trees and landscaping do not impair solar rights. In the opinion of the City's legal consultants, the proposed ordinance falls within the scope of public action permissable under the exercise of a community's policy power. Its transferability in part or whole to Riverside would appear to entail no significant legal uncertainties.

In summary, a number of options are available to Riverside to implement revisions in the existing zoning ordinance to insure solar access. Although current State easement and local zoning laws probably are adequate to protect the solar access of individual property owners, a high impact energy strategy is best served by explicit recognition of solar rights within, or in addition to, existing laws. Such action is consistent with that of numerous jurisdictions across the country. It is a key supportive element in the successful implementation of Riverside's energy strategy.

Retrofit Code. Enactment of a building retrofit code in support of a city-wide retrofit code would be the most stringent, effective and least publicly acceptable form of achieving energy savings in existing buildings. Opposition of a retrofit code is likely to come from a majority of homeowners who view such an ordiance as both costly and an infringement upon individual choice. Further difficulties may arise if the ordinance is tested in the courts, a real possiblity in view of the nonexistence (to our knowledge) of such an ordinance in other municipalities. For these reasons, whether a public education or incentives approach is probably more workable, though clearly less effective. If, however, the municipality opted for a retrofit code, a performance (versus perspective) type approach will probably generate less adverse public reaction. Enforcement, on the other hand, will be more costly and probably less effective if a performance-based ordinance is enacted.

SELECTION OF ALTERNATIVE ENERGY STRATEGIES

This section of the report discusses the methodology used by Battelle to select alternative energy strategies for Riverside. Strategy is defined in this case as a combination of conservation and alternative energy supply options with generally similar evaluation results.

The purpose of this section was to compare conservation and alternative energy supply options in terms of primary and secondary outcomes as well as feasibility of implementation. Because quantitative analyses had already been performed on each selected option in order to estimate the primary outcome (energy savings or displacement) and its effect on environmental quality, the initial effort was to compare the options with those evaluation factors for which only qualitative information was available. As a result, the evaluation factors considered at this time included local economic impact, energy supply stability, lifestyle, public acceptance, legal/institutional, technological availability, and public/private sector costs. This qualitative comparison was performed using a methodology similar to that used in the screening analysis. All of the building, community design, industry and transportation conservation options, as well as the alternative energy supply options, were listed in a matrix with the evaluation criteria. Each option was then judged in relation to each evaluation factor and a set of evaluation impacts/effects scaled to range from 0 to 10. The evaluation factors, their impacts/effects, and the numerical values for each are shown in Table 45. Table 46 shows the secondary outcomes and feasibility for the selected options.

TABLE 45. Evaluation Criteria for Selected Conservation and Alternative Energy Supply Options

Factor	Impact/Effect	Value
Local Economy	• High potential for additional employment or new industry; low impact on general revenue fund.	10
	• No potential for additional employment or new industry; high impact on general revenue fund.	0

Factor	Impact/Effect	Value
Energy Supply Stability	• High reliability under possible upset conditions (oil embargo, coal strike); nondepletable resource	10
	• Low reliability under possible upset conditions; depletable resource	0
Lifestyle	• Minimal or positive anticipated life-style changes	10
	• Potential for negative lifestyle changes on community-wide basis	0
Public Acceptance	• Definitely acceptable	10
	• Unacceptable; public reaction can jeopardize project success	0
Legal/ Institutional	• No changes in ordinances or codes; no political opposition	10
	• Major changes in ordinances or codes; probable major political opposition	0
Technological Availability	• Extensive development prior to commer-cialization of key technologies required	10
	• Limited to no development required for commercialization of all technologies	0
Public/Private Sector Costs	• Life cycle costs significantly lower than current trends	10
	• Life cycle costs higher than current trends.	0

A total value considering all the criteria was then developed for each option. These values were then compared with the estimated energy savings and the estimated impact on the quality of the environment determined for a low, moderate, and high population growth rate (Tables 47, 48, and 49). As a part of this comparative analysis, conservation and supply options having the same relative ranking were then clustered and became the basis for the recommended alternative energy strategies:

TABLE 46. QUALITATIVE ANALYSIS OF SECONDARY OUTCOMES AND FEASIBILITY FACTORS OF CONSERVATION AND SUPPLY OPTIONS

	Secondary Outcomes						Feasibility									
	Local Economy		Energy Supply Stability		Lifestyle		Public Acceptance		Legal/Institutional		Technology Availability		Public/Private Sector Costs		Total All Values	
Options	Impact/Effect	Value	Impact/Effect	Value	Impact/Effect	Value	Impact/Effect	Value	Impact/Effect	Value	Impact/Effect	Value	Impact/Effect	Value		Category
Conservation																
(C1) Building retrofit	Sig[illegible] increase in c[illegible] of administering codes; significant increase in building trades employment and sales of building materials, i.e, insulation, storm windows	7	No appreciable effect	5	Increased comfort due to reduced infiltration, heat gains, heat loss	8	Probable rejection of added costs particularly among low and moderate income homeowners as well as business	3	Need to adopt retrofit code; increase in plan review and inspection staff; probable political opposition	1	Technology required readily available	10	Life cycle costs about the same or slightly lower	6	40	C
(C2) State building codes	Some increase in cost of administering building code; some increase in sales of building materials, i.e., insulation, insulating glass	6	No appreciable effect	5	Increased comfort in new building due to reduced infiltration, heat gain, and heat loss	10	Definitely acceptable, costs already included in construction costs	10	Need to educate staff; additional plan review	9	Same as above	10	Life cycle costs significantly lower than business as usual	8	58	A
(C3) Continued improvement of energy codes for new and existing buildings	No appreciable effect	5	No effect	5	Increased comfort due to reduced infiltration, heat gain, and heat loss	10	Public acceptance depends upon degree of change and cost; probable limited opposition, generally	8	No major obstacles	8	No constraints anticipated at this time	10	Life cycle costs about the same as business as usual	5	51	B
(C4) Modified housing mix	No effect on employment or general revenue fund	5	No appreciable effect	5	Some reduction in privacy	7	Possible opposition to spatial distribution and staging of new multifamily units; changes in overall density	4	Probable opposition to rezoning; rezoning hearings required	4	Same as above	10	Life cycle costs somewhat lower than business as usual	6	41	C
(C5) Energy-efficient neighborhood development	Seen as more secure investment due to initial value and capability of projecting future value. Less subject to abrupt changes effecting property values	10	Reduction in demand for vehicle fuel in Riverside; no effect on reliability	5	Reduced dependence on auto; more leisurely environment; greater perception of personal safety; greater emphasis on preserving nature	10	Marketing of energy efficiency and new lifestyle could create a backlog of occupants; early possible opposition to development standards by builders	8	Some modifications and integration of C-1 and planned residential development (PRD) uses required; probable political opposition	6	Same as above	10	Life cycle costs significantly lower than business as usual	8	57	A
(C6) Planning policy to encourage use of passive solar building design (building orientation)	No effect on employment. Increased building value over buildings with traditional orientation adding to municipal tax revenues	6	Some increase in supply stability due to use of alternative energy resource and some displacement	6	Reduction in variety of street layout	8	Possibly some opposition by builders/developers	9	Some difficulty in developing and adopting a solar-based zoning ordinance and revising subdivision code	4	No constraint	10	Life cycle costs somewhat lower than business as usual	6	49	B
(C7) Passive solar thermal standard	Same as above	6	Slight increase in supply stability due to expected use of alternative energy resource and some displacement	6	Possible reduction in variety of building design; possible loss of living space	8	Increased property value should offset any opposition to design similarity or loss of space; probable builder opposition to standards	10	Same as above	4	Currently some limitations exist in efficient thermal storage; expected to be resolved before 2000	8	Life cycle costs about the same as business as usual	5	47	B
(C8) Passive solar cooling standard	Same as above	6	No effect because electricity is generated outside the city and the city has no control over	5	Improved temperature control for the building and adjacent areas such as patios	10	Same as above	10	Same as above	4	Same as above	9	Life cycle costs somewhat lower than business as usual	6	50	B
(C9) Convert street lamps to high pressure sodium	Some capital investment by city; some reduction in operating cost to City. No effect on employment	5	Same as above	5	Loss of warmth and intimacy due to change in lighting effect	5	No obstacles	10	No obstacles	10	Technology required readily available	10	Life cycle costs about the same or slightly higher than business as usual	4	49	B
(C10) Reduce total energy demand in street lighting system	Capital investment required by City. No effect on employment	5	Same as above	5	Possible decrease in perception of safety	7	Possible negative response to reduced lighting levels	6	No obstacles	9	Same as above	10	Life cycle costs somewhat lower than business as usual	6	48	B
(C11) Education programs on energy-efficient industrial production and operations	No appreciable effect	5	No appreciable effect	5	No effect	10	No obstacles	10	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	7	57	A
(C12) Education programs on vanpooling, carpooling, purchasing fuel-efficient vehicles, driving efficiencies	Some decrease in tax income from fuels; savings realized by individuals	6	No effect	5	Less privacy in travel; fewer options in choice of vehicle size; contention with possible restrictions discouraging private autos	6	Low probability of acceptance due to resistance to change in use of private autos	2	No obstacles	10	No constraints in achieving education program	10	Life cycle costs somewhat lower than business as usual	8	47	B

TABLE 46. (Continued)

Options	Secondary Outcomes: Local Economy Impact/Effect	Value	Energy Supply Stability Impact/Effect	Value	Lifestyle Impact/Effect	Value	Feasibility: Public Acceptance Impact/Effect	Value	Legal/Institutional Impact/Effect	Value	Technology Availability Impact/Effect	Value	Public/Private Sector Costs Impact/Effect	Value	Total All Values	Category
Supply																
(S1) Solar water/space heat	Systems require variable investment depending on degree of service desired	6	Shifts reliance to nondepletable resource. Requires backup under normal conditions. Would be functional under upset conditions	7	Negligible	5	Excellent — may even override some degree of increased cost over next best alternative	10	No effect. Systems are currently being commercially installed	10	Commercial — Advancements offer hope of lower costs	10	Can be cost competitive with electric heat but probably not with natural gas. Will increase local trades employment	8	56	A
(S2) Investment in remote conventional generating plants, coal/nuclear	Investment is variable depending on degree of service desired. Benefit is linear with investment	9	Shifts reliance to nonscarce resource. Highly dependable under normal conditions. Not dependable under upset conditions	7	Negligible	5	Public acceptance has had major impact on failure of previous projects such as Kaiparowits and Sundesert	6	Legal and institutional mechanisms already exist	10	Commercial — However, pollution control and waste disposal require development	8	Would result in lower cost of electric power for Riverside residents	10	55	A
(S3) Investment in remote nonconventional generating plants, geothermal/wind	Same as above. Cost/benefit uncertain at this time	6	Shifts reliance to nonscarce or nondepletable resource. Dependability under normal and upset conditions needs to be proven	8	Negligible	5	Probably somewhat less negative than to S2 due to newness of technology	6	Could be handled under same agreement as S2. Some additional problems exist for geothermal	9	Noncommercial Both geothermal and wind will require development and economic demonstration	7	Would result in lower cost of power contingent on technology development	7	48	B
(S4) Integrated utility system based on gasification of coal and refuse	Large investment required even for minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Less dependable than S2 under normal conditions — somewhat more dependable under upset conditions	7	Some temporary disruptive effect due to construction	4	Will depend largely on how effectively project can be sold to the public. Unlike S2 and S3 the people most affected by the plant are those who benefit from its service	5	Could be handled under same conditions as S2. Plant generator would need mechanism for sale of steam and chilled water	9	Noncommercial. Projected technology commercialization in late 1980's	7	Would result in lower cost of power contingent on technology development. Would increase local employment. Requires substantial initial investment	7	45	B
(S5) Hydrogen production for captive vehicle fleet	Moderate to large investment required. Benefit increases with investment	5	Shifts reliance to nonscarce resource. Increased dependability of fuel supply. Engine dependability needs demonstration	7	Negligible	5	Good for general public for environmental reasons. Poor for drivers and mechanics which could seriously affect success of project	5	No effect	10	Noncommercial. Both production and end use systems require development and demonstration	7	Negligible impact	5	44	B
(S6) Methane from wastes. Landfill, feedlot manure, sewage sludge	Relatively small investment required	6	Shifts reliance to nondepletable resource. Dependability under normal and upset conditions lower than conventional natural gas	6	Negligible	5	Little or no public reaction expected	5	No effect. Systems are currently in commercial use in other locations	10	Commercial	8	Potentially lower cost of natural gas but probably negligible impact	5	45	B
(S7) Geothermal district heating/cooling	Large investment for even minimal plant. Benefit increases as investment increases	6	Shifts reliance to nonscarce resource. Dependability under normal conditions needs demonstration. Dependability under upset conditions somewhat higher than S2, S3, and S4	7	Some temporary disruptive effect due to construction	3	Somewhat more acceptable than S3	5	Plant operator would need mechanism for sale of hot water	9	Noncommercial. Possibilities depend highly on resource characteristics	3	May result in lower heating and cooling costs. Highly dependent on resource capacity and characteristics	7	40	C

TABLE 47. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF LOW POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings			Environmental Impact (Decrease in Emissions, lb x 10^3/yr)					Secondary Outcomes and Feasibility
	Impact	Savings (BTU's x 10^{12})		HC	CO	NO_x	SO_2	Particulates	Values
Building Retrofit Code	Low	.660	(a)	4.3	8.3	152.3	86.6	10.3	40
	Moderate	.923	(a)	6.1	11.5	212.6	120.9	14.4	40
	High	1.186	(a)	7.8	14.9	272.0	154.4	18.4	40
State Energy Code	Low	.187	(a)	1.2	2.6	41.4	23.0	2.8	58
	Moderate	.333	(a)	2.1	4.8	70.5	38.6	4.8	58
	High	.508	(a)	3.8	7.5	132.7	74.9	9.0	58
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable			–	–	–	–	–	51 51 51
Modified Housing Mix	Low	.013	(b)	.11	.26	4.8	2.7	.33	41
	Moderate	.044	(b)	.47	.89	16.1	9.2	1.1	41
	High	.08	(b)	.84	1.6	29.5	16.7	2.0	41
Energy-Efficient Neighborhood Development	High Only	.321	(b)	192.6	2535.9	417.3	16.1	41.7	57
Planning Poilicy to Encourage Use of Passive Solar Building	No Direct Savings Attributable			–	–	–	–	–	49
Passive Solar Thermal Standard	Low	.141	(b)	.494	4.230	13.677	.085	.846	47
	Moderate	.231	(b)	.809	6.930	22.407	.139	1.386	47
	High	.266	(b)	.931	7.980	25.802	.160	1.596	47
Passive Solar Cooling Standard	Low	.126	(b)	2.268	.044	80.64	52.668	5.544	50
	Moderate	.187	(b)	3.366	.065	119.68	78.166	8.228	50
	High	.286	(b)	5.148	.100	183.04	119.548	12.584	50
Convert Incandescent Lights to High Pressure Sodium	Low	.028	(b)	.50	.01	17.9	11.7	1.2	49
	Moderate	.028	(b)	.50	.01	17.9	11.7	1.2	49
	High	.028	(b)	.50	.01	17.9	11.7	1.2	49
Reduce Total Energy Demand in Street Lighting	Low	.033	(b)	.594	.012	21.12	13.794	1.452	48
	Moderate	.038	(b)	.684	.013	24.32	15.884	1.672	48
	High	.105	(b)	1.89	.037	67.2	43.89	4.62	48
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.533	(c)	.533	2.132	94.341	99.671	4.797	57
	Moderate	.791	(c)	.791	3.164	506.240	147.917	7.119	57
	High	1.045	(c)	1.045	4.18	184.965	195.415	9.405	57
Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.696	(d)	417.6	5498.4	904.8	34.8	90.5	47
	Moderate	1.043	(d)	625.8	8239.7	1355.9	52.2	135.6	47
	High	1.393	(d)	835.8	11004.7	1810.9	69.7	181.1	47
Integrated Utility System Based on Gasification of Coal and Refuse	Low	5.9	(e)	100.	-65.	1600.	600.	65.	45
	Moderate	7.2	(e)	120.	-80.	2000.	800.	80.	45
	High	8.7	(e)	150.	-100.	2500.	1000.	100.	45
Solar Water and Space Heating	Low	0.8	(f)	2.8	28.	78.	0.5	4.8	50
	Moderate	1.0	(f)	3.5	35.	98.	0.6	6.0	50
	High	1.9	(f)	6.6	66.	186.	1.1	11.4	50
Geothermal District Heating	Low	1.9	(g)	51.	39.	184.	1.1	11.	40
	Moderate	2.3	(g)	62.	48.	224.	1.4	14.	40
	High	2.8	(g)	76.	58.	273.	1.7	17.	40
Methane From Wastes	All	0.2	(h)	Essentially No Change					45
Remote Generator	All	14.3	(i)	257.	5.	9152.	6000.	630.	55
Hydrogen Vehicles	All	0.21	(j)	126.	1659.	273.	10.5	27.3	44

For assumptions and detailed calculations, see
(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

TABLE 48. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF MODERATE POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings			Environmental Impact (Decrease in Emissions, lb x 10^3/yr)					Secondary Outcomes and Feasibility Values
	Impact	Savings (BTU's x 10^{12})		HC	CO	NO_x	SO_2	Particulates	
Building Retrofit Code	Low	.660	(a)	4.3	8.3	152.3	86.6	10.3	40
	Moderate	.923	(a)	6.1	11.5	212.6	120.9	14.4	40
	High	1.186	(a)	7.8	14.9	272.0	154.4	18.4	40
State Energy Code	Low	.283	(a)	1.8	4.1	63.7	35.2	4.3	58
	Moderate	.476	(a)	2.9	7.1	101.5	55.3	6.9	58
	High	.715	(a)	4.4	10.5	153.3	83.8	10.4	58
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable			–	–	–	–	–	51
									51
									51
Modified Housing Mix	Low	.025	(b)	.26	.5	9.2	5.2	.63	41
	Moderate	.079	(b)	.83	1.6	29.1	16.5	2.0	41
	High	.142	(b)	1.5	2.8	52.3	29.7	3.6	41
Energy-Efficient Neighborhood Development	High Only	.573	(b)	343.8	4526.7	744.9	28.7	74.5	57
Planning Policy to Encourage Use of Passive Solar Building	No Direct Savings Attributable			–	–	–	–	–	49
Passive Solar Thermal Standard	Low	.252	(b)	.882	7.560	24.444	.151	1.512	47
	Moderate	.412	(b)	1.442	12.360	39.964	.247	2.472	47
	High	.475	(b)	1.663	14.250	46.075	.285	2.850	47
Passive Solar Cooling Standard	Low	.187	(b)	3.4	.065	119.7	78.2	8 2	50
	Moderate	.293	(b)	5.3	.103	187.5	122.5	12.9	50
	High	.393	(b)	7.1	.138	251.5	164.3	17.3	50
Convert Incandescent Lights to High Pressure Sodium	Low	.028	(b)	.50	.01	17.9	11.7	1.2	49
	Moderate	.028	(b)	.50	.01	17.9	11.7	1.2	49
	High	.028	(b)	.50	.01	17.9	11.7	1.2	49
Reduce Total Energy Demand in Street Lighting	Low	.038	(b)	.68	.013	24.3	15.9	1.7	48
	Moderate	.076	(b)	1.37	.03	48.6	31.8	3.3	48
	High	.114	(b)	2.05	.04	72.9	47.7	5.0	48
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.627	(c)	.63	2.5	110.9	117.3	5.6	57
	Moderate	.927	(c)	.93	3.7	164.1	173.4	8.3	57
	High	1.223	(c)	1.22	4.9	216.5	228.7	11.0	57
Education Program on Vanpooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.801	(d)	480.6	6327.9	1041.3	40.1	104.1	47
	Moderate	1.202	(d)	721.2	9495.8	1562.6	60.1	156.3	47
	High	1.603	(d)	961.8	12663.7	2083.9	80.2	208.4	47
Integrated Utility System Based on Gasification of Coal and Refuse	Low	7.2	(e)	120.	-80.	2000.	800.	80.	45
	Moderate	8.7	(e)	150.	-100.	2500.	1000.	100.	45
	High	10.5	(e)	180.	-120.	3000.	1200.	120.	45
Solar Water and Space Heating	Low	1.0	(f)	3.5	35.	98.	0.6	6.0	50
	Moderate	1.2	(f)	4.2	42.	118.	0.7	7.2	50
	High	2.0	(f)	6.7	67.	188.	1.1	11.5	50
Geothermal District Heating	Low	2.3	(g)	62.	48.	224.	1.4	14.	40
	Moderate	2.8	(g)	76.	58.	273.	1.7	17.	40
	High	3.4	(g)	93.	71.	333.	2.1	21.	40
Methane From Wastes	All	0.2	(h)	Essentially No Change					45
Remote Generation	All	14.3	(i)	257.	5.	9152.	6000.	630.	50
Hydrogen Vehicles	All	0.24	(j)	144.	1896.	312.	12.	31.2	44

For assumptions and detailed calculations, see
(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

TABLE 49. COMPARISON OF ENERGY SAVINGS, ENVIRONMENTAL IMPACTS WITH SECONDARY OUTCOMES AND FEASIBILITY ISSUES IN TERMS OF HIGH POPULATION GROWTH RATE IN THE YEAR 2000

Options	Energy Savings		Environmental Impact (Decrease in Emissions, lb x 10^3/yr)					Secondary Outcomes and Feasibility Values
	Impact	Savings	HC	CO	NO_x	SO_2	Particulates	
		(BTU's x 10^{12})						
Building Retrofit Code	Low	.660 (a)	4.3	8.3	152.3	86.6	10.3	40
	Moderate	.923 (a)	6.1	11.5	212.6	120.9	14.4	40
	High	1.186 (a)	7.8	14.9	272.0	154.4	18.4	40
State Energy Code	Low	.394 (a)	2.4	5.9	84.8	46.1	5.7	58
	Moderate	.631 (a)	3.9	9.3	135.7	74.1	9.2	58
	High	.904 (a)	5.7	12.7	197.7	109.3	13.4	58
Continued Upgrading of Energy Codes for New and Existing Buildings	Savings too Variable		–	–	–	–	–	51 / 51 / 51
Modified Housing Mix	Low	.039 (b)	.41	.79	14.4	8.2	.98	41
	Moderate	.124 (b)	1.3	2.5	45.7	25.9	3.1	41
	High	.222 (b)	2.3	4.5	81.8	46.5	5.6	41
Energy-Efficient Neighborhood Development	High Only	.900 (b)	540.0	7110.0	1170.0	45.0	117.0	57
Planning Policy to Encourage Use of Passive Solar Building	No Direct Savings Attributable		–	–	–	–	–	49
Passive Solar Thermal Standard	Low	.395 (b)	1.383	11.850	38.315	.237	2.370	47
	Moderate	.646 (b)	2.261	19.380	62.662	.388	3.876	47
	High	.745 (b)	2.608	22.350	72.265	.447	4.470	47
Passive Solar Cooling Standard	Low	.276 (b)	5.0	.097	176.6	115.4	12.1	50
	Moderate	.416 (b)	7.5	.146	266.2	173.9	18.3	50
	High	.540 (b)	9.7	.19	345.6	225.7	23.8	50
Convert Incandescent Lights to High Pressure Sodium	Low	.028 (b)	.50	.01	17.9	11.7	1.2	49
	Moderate	.028 (b)	.50	.01	17.9	11.7	1.2	49
	High	.028 (b)	.50	.01	17.9	11.7	1.2	49
Reduce Total Energy Demand in Street Lighting	Low	.045 (b)	.81	.016	28.8	18.8	1.98	48
	Moderate	.089 (b)	1.60	.031	56.9	37.2	3.9	48
	High	.134 (b)	2.41	.047	85.8	56.0	5.9	48
Education Program to Improve Efficiency of Industrial Processes and Operations	Low	.740 (c)	.74	2.96	131.0	138.4	6.7	57
	Moderate	1.095 (c)	1.09	4.38	193.8	204.8	9.9	57
	High	1.443 (c)	1.44	5.77	255.4	269.8	13.0	57
Education Program on Vanpooling/Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies	Low	.939 (d)	563.4	7418.1	1220.7	47.0	122.1	47
	Moderate	1.408 (d)	844.8	11123.2	1830.4	70.4	183.0	47
	High	1.878 (d)	1126.8	14836.2	2441.4	93.9	244.1	47
Integrated Utility System Based on Gasification of Coal and Refuse	Low	8.7 (e)	150.	-100.	2500.	1000.	100.	45
	Moderate	10.5 (e)	180.	-120.	3000.	1200.	120.	45
	High	12.8 (e)	200.	-140.	3700.	1600.	150.	45
Solar Water and Space Heating	Low	1.3 (f)	4.6	46.	127.	0.8	8.	50
	Moderate	1.3 (f)	4.6	46.	127.	0.8	8.	50
	High	2.2 (f)	7.7	77.	216.	1.3	13.	50
Geothermal District Heating	Low	2.8 (g)	76.	58.	273.	1.7	17.	40
	Moderate	3.4 (g)	93.	71.	333.	2.1	21.	40
	High	4.1 (g)	113.	87.	406.	2.6	26.	40
Methane From Wastes	All	0.2 (h)			Essentially No Change			45
Remote Generation	All	14.3 (i)	257.	5.	9152.	6000.	630.	55
Hydrogen Vehicles	All	0.38 (j)	228.	3002.	494.	19.	49.	44

For assumptions and detailed calculations, see
(a) Volume 2, Appendix C1, Attachment C1-1.
(b) Volume 2, Appendix C4, Attachment C4-1.
(c) Volume 2, Appendix C2, Attachment C2-2.
(d) Volume 2, Appendix C3, Attachment C3-1.
(e) See Appendices D9-D10.
(f) See Appendix D2.
(g) Equivalent to natural gas displaced in IUS application areas. See Appendices D9-D10.
(h) See Appendix D5.
(i) Impact assumes implementation schedule as shown in reference D4-3. Emission estimate based on equivalent SCE power displaced with emissions factors from Table D10-1.
(j) See Appendix C3, Attachment C3-1.

Alternative Strategy A (minimum)
Alternative Strategy B (moderate)
Alternative Strategy C (maximum).

Alternative Strategy A (minimum)

Alternative Strategy A includes the following conservation, supply, and institutional options:

Conservation

- Optimum Administration of New Residential and Nonresidential State Energy Codes
- Development and Implementation of a Land Use Policy Emphasizing Concentrated Planned Neighborhood Development Incorporating Mixed Uses.
- Development and Implementation of an Ongoing Education Program to Improve the Efficiency of Industrial Processes and Operations in Small Industry.

Supply

- Solar Water and Space Heating
- Investment in Remote Conventional Generating Plants
- Reevaluation of Remote Non-Conventional Generating Plants Based on Future Technology
- Reevaluation of Integrated Utility Systems Based on Future Technology.

Institutional

- Appointment of a City Energy Coordinator.

These options have the following general qualitative characteristics:

Conservation

Local Economy	Ranges from no appreciable effect to some increase in cost of public administration
Energy Supply Stability	No appreciable effect
Lifestyle	Ranges from no effect to increased comfort due to additional weatherization and greater convenience
Public Acceptance	No major obstacles
Legal/Institutional Constraints	Ranges from no obstacles to some modification and integration of planned residential development (PRD)
Public/Private Sector Costs	Life cycle costs range from low to significantly lower than business as usual.

Supply

Local Economy	These options tend to either provide lower cost of service to Riverside or provide increased employment locally
Energy Supply Stability	None of the options varied substantially under this criterion
Lifestyle	None of the options varied substantially
Public Acceptance	Options were mixed under this criterion
Legal/Institutional	All options ranked high since none require substantial institutional changes
Technological Availability	These options tend to rely on more developed proven technology
Public/Private Sector Costs	These options tend to require variable or minimal investment.

Alternative Strategy B (moderate)

Alternative Strategy B includes the following conservation, supply, and institutional options:

Conservation

- All Strategy A Options
- Development and Implementation of a Planning Policy to Encourage the Use of Passive Solar Building Design
- Development and Implementation of a Minimum Winter Performance Standard, Including Passive Solar Thermal Systems on New Single-Family Detached and Duplex Units
- Development and Implementation of a Minimum Summer Performance Standard, Including Passive Solar Shading and Shielding Devices on New Single-Family and Low-Rise Residential Units and Encouraged Use of Such Devices on Existing Units
- Replacement of Existing Incandescent Street Lights with High Pressure Sodium
- Reduction of Total Energy Demand in the Street Lighting System
- Development and Implementation of an Ongoing Education Program on Van-pooling, Carpooling, Purchasing Fuel Efficient Vehicles, Driving Efficiencies.

Supply

- All Strategy A Options
- Hydrogen Production for Municipal Fleet
- Methane from Waste Landfill.

Institutional

- Strategy A Option
- Development and Implementation of a Solar-Based Zoning Ordinance.

Aside from Strategy A options, these options have the following general qualitative characteristics:

Conservation

Local Economy	Greater stability in property values; some capital investment by the City; no major effect on employment
Energy Supply Stability	Some increase in community supply stability
Lifestyle	Some reduction in variety of street and building design; less privacy; fewer options particularly in residential design and auto travel
Public Acceptance	Probably builder/developer opposition to solar standards
Legal/Institutional	Ranges from no obstacles to some possible political opposition to solar standards
Public/Private Sector Costs	Life cycle costs range from slightly lower to slightly higher than business as usual.

Supply

Local Economy	These options tend to have questionable economic competitiveness with conventional alternatives but with expected technology development could be competitive in the future
Energy Supply Stability	No appreciable effect
Lifestyle	No appreciable effect
Public Acceptance	Options were mixed
Legal/Institutional	No effect--see Strategy A
Technological Availability	These options tend to rely on relatively undeveloped technology
Public/Private Sector Costs	These options tend to require substantial investment.

Alternative Strategy C (maximum)

Alternative Strategy C includes the following conservation and supply options:

Conservation

- All Strategy A Options
- All Strategy B Options
- Development and Implementation of a Building Retrofit Code
- Development and Implementation of a Land-Use Policy to Modify the Housing Mix
- Continued Upgrading of an Energy Code(s)

Supply

- All Strategy A Options
- All Strategy B Options
- Geothermal District Heating System

Institutional

- Strategy A Option
- Strategy B Option

Aside from Strategy A and B Options, these options have the following general qualitative characteristics:

Conservation

Local Economy	Significant increase in cost of administering codes and planning policies; significant increase in need for construction employment and materials

Energy Supply Stability	No appreciable effect
Lifestyle	Increased comfort due to additional weatherization; some reduction in privacy
Public Acceptance	Probable rejection of added costs for weatherization; possible strong opposition to multifamily housing
Legal/Institutional	Need to develop and adopt a retrofit code; probable opposition to rezoning for a greater amount of duplex and low-rise multifamily dwelling units; probably political opposition
Public/Private Sector Costs	About the same to slightly lower than business as usual.

Supply

Local Economy	Basically the same as B
Energy Supply Stability	No effect
Lifestyle	No effect
Public Acceptance	Options were mixed
Legal/Institutional	No substantial changes required
Technological Availability	These options tend to have large uncertainties as to future development
Public/Private Sector Costs	These options tend to require large investments.

For a detailed description of the above options, see Volume 2, Appendix C1 (buildings); Appendix C2 (industry); Appendix C3 (transportation); Appendix C4 (community design); Volume 3, Appendix D (alternate energy).

Graphical Illustration of Reductions on Consumption

Figure 29 is a bar chart illustrating the potential impact on energy supply of selected conservation and supply options evaluated in this study. This figure is divided into four basic bars--business as usual, minimum strategy/low impact, moderate strategy, moderate impact, maximum strategy/high impact. The following describes the basic assumptions and contents in each bar.

Business as Usual - This bar represents the mix of energy sources that would be used in the year 2000 if current trends continue. Specific assumptions were (1) Electric demand growth at 4 percent per year,* (2) population growth 2.17 percent per year, ** (3) natural gas demand growth 2.17 percent per year (constant per capita consumption, and (4) vehicle oil demand 2.17 percent per year.

Minimum Strategy/ Low Impact - This bar represents the most likely mix of energy sources in the year 2000. The items in this bar appear to be most cost effective and easiest to implement based on current projections. They include:

Conservation - All the items in Category A in Tables ES-2, ES-3, and ES-4.

Solar - Domestic hot water heating only. Thirty percent implementation in existing single family residences and 70 percent in new single family residences.

Remote Electric - Investment in San Onofre 1.8 percent, Intermountain Power 6 percent, and Palo Verde 1 percent.

Purchased Electric - Approximately 38 percent of Riverside's electric needs purchased from utilities.

Natural Gas and Oil - Still purchased as in Business as Usual case.

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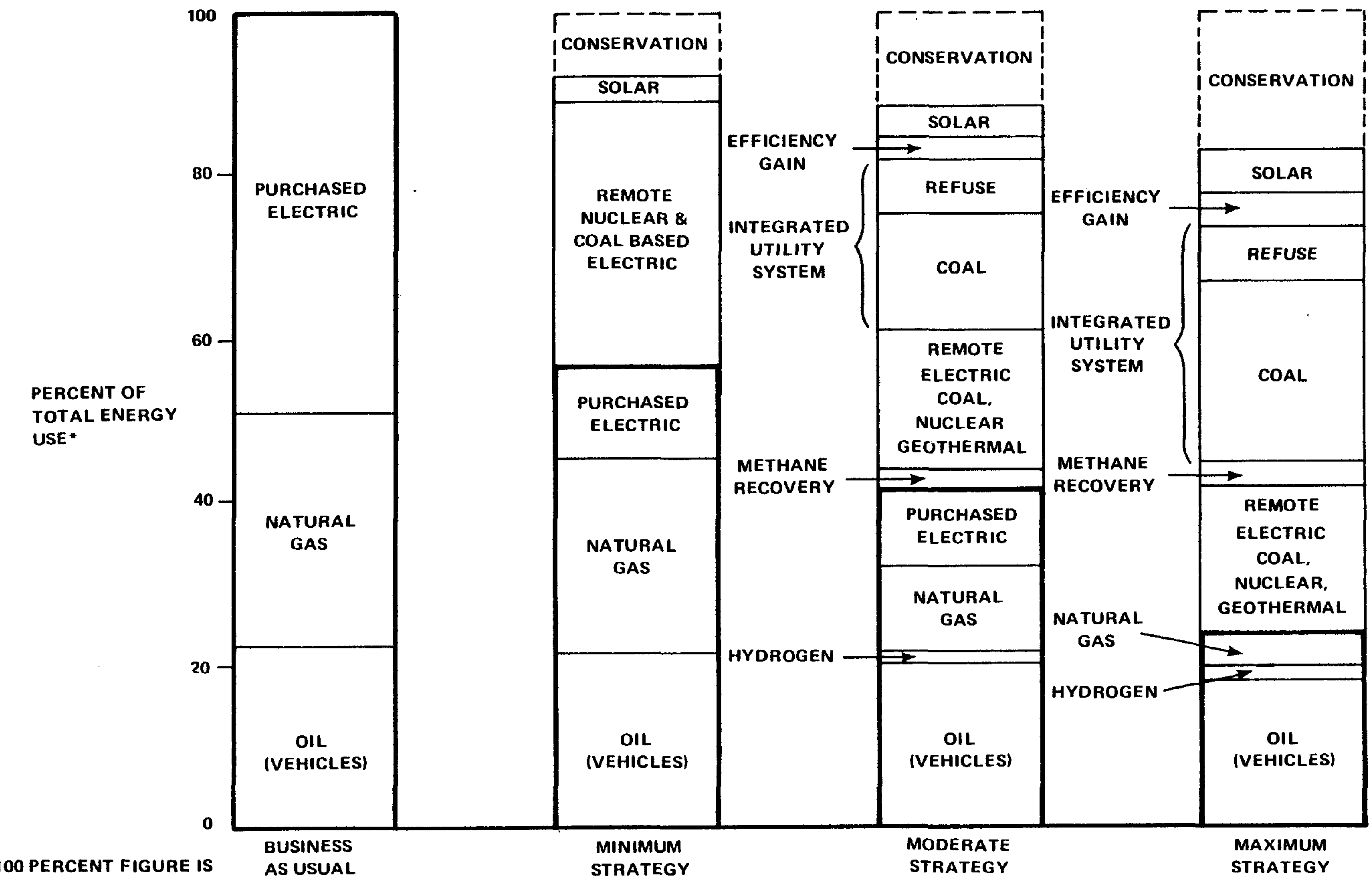
* Growth rate projected by the Riverside Public Utilities Department.

** This represents the high population growth rate considered elsewhere in this study. This growth rate appears most likely for Riverside based on discussions with the Riverside Public Utilities Department.



*THE 100 PERCENT FIGURE IS APPROXIMATELY EQUIVALENT TO 43 X 10^{12} BTU/YEAR OR 7.2 X 10^{6} BARRELS OF OIL PER YEAR.

FIGURE 29. EFFECT OF IMPLEMENTING SELECTED ENERGY SUPPLY AND CONSERVATION OPTIONS ON RIVERSIDE ENERGY USE IN THE YEAR 2000

<u>Moderate Strategy/</u>
<u>Moderate Impact</u> - This bar includes items that may prove to be cost effective and beneficial to implement by the year 2000. However, they are generally more difficult to implement or require more rapid technology development than can be projected at this time. They include:

<u>Conservation</u> - All of items in Categories A and B from Tables ES-2, ES-3, and ES-4.

<u>Solar</u> - Domestic hot water heating only. 50 percent implementation in existing residences and 100 percent in new residences.

<u>Integrated Utility System</u> serves census tracts 303, 304, 305, and 422.03 with steam and chilled water. Also generates about 30 percent of Riverside's electric needs. Efficiency gain represents net fuel savings as a result of the cogeneration of steam and electricity. Coal and refuse are converted to a gaseous fuel for use in the plant.

<u>Remote Electric</u> - Investment in remote plants may include some geothermal sources. Total remote investment reduced from previous case to satisfying about 32 percent of Riverside's electric needs.

<u>Methane Recovers</u> through anaerobic digestion of feedlot manure and refuse as a direct replacement for natural gas.

<u>Purchased Electric</u> - Maintained at about 38 percent of Riverside's electric needs as in previous case.

<u>Hydrogen</u> produced from electrolysis of water used in portion of Riverside captive vehicle fleet.

<u>Natural Gas and Oil</u> - Still purchased as in Business as Usual.

Maximum Strategy/
High Impact - This bar differs from the previous bar primarily in degree of implementation although some conservation items are added. This bar includes:

Conservation - All items listed under conservation in Tables ES-2, ES-3, and ES-4.

Solar - Domestic hot water and space heating. 70 percent implementation in existing residences and 100 percent in new residences.

Integrated Utility System - Expanded version of previous case serving census tracts 303, 304, 305, 422.03, 422.02, 307, and 311. Plant uses refuse and coal as source of gaseous fuel and generates about 41 percent of Riverside's electric needs.

Remote Electric - Approximately the same as in minimum case.

Methane Recovery - Same as in previous case.

Purchased Electric - This case assumes that Riverside would be responsible for all of its own electric needs and no purchased electric would be required.

Hydrogen - Same as in previous case only expanded to entire captive vehicle fleet.

Natural Gas and Oil - Still purchased as in Business as Usual.

Projected demand will be reduced by means of conservation and (1) coal and refuse in the integrated utility system, which also supplies steam for industrial and commercial use and electricity, (2) solar energy for residential use, and (3) some methane recovery from waste for general heating use. There is also an efficiency gain from using coal and refuse in the integrated utility system which has the effect of reducing demand, as shown. Hydrogen, produced by electrolysis, is assumed to be used in Riverside's municipal fleet and is shown as supplying part of the petroleum demand for vehicles.

All of the impact assumptions are effective in reducing dependence on purchased fuels. Implementation of any alternative energy strategy should lead to greater stability of energy supply and costs for Riverside. In 2000, under the high impact assumption, energy for Riverside based on natural gas and oil--can be about one-half of that in 1976, and about one-third of that in 2000 on a business-as-usual basis. The advantage of striving for a high impact strategy is also apparent by noting that in the year 2000, the high impact strategy results in an energy purchase of about one-half that which would be bought under a low impact strategy.

RECOMMENDED ACTION PLAN

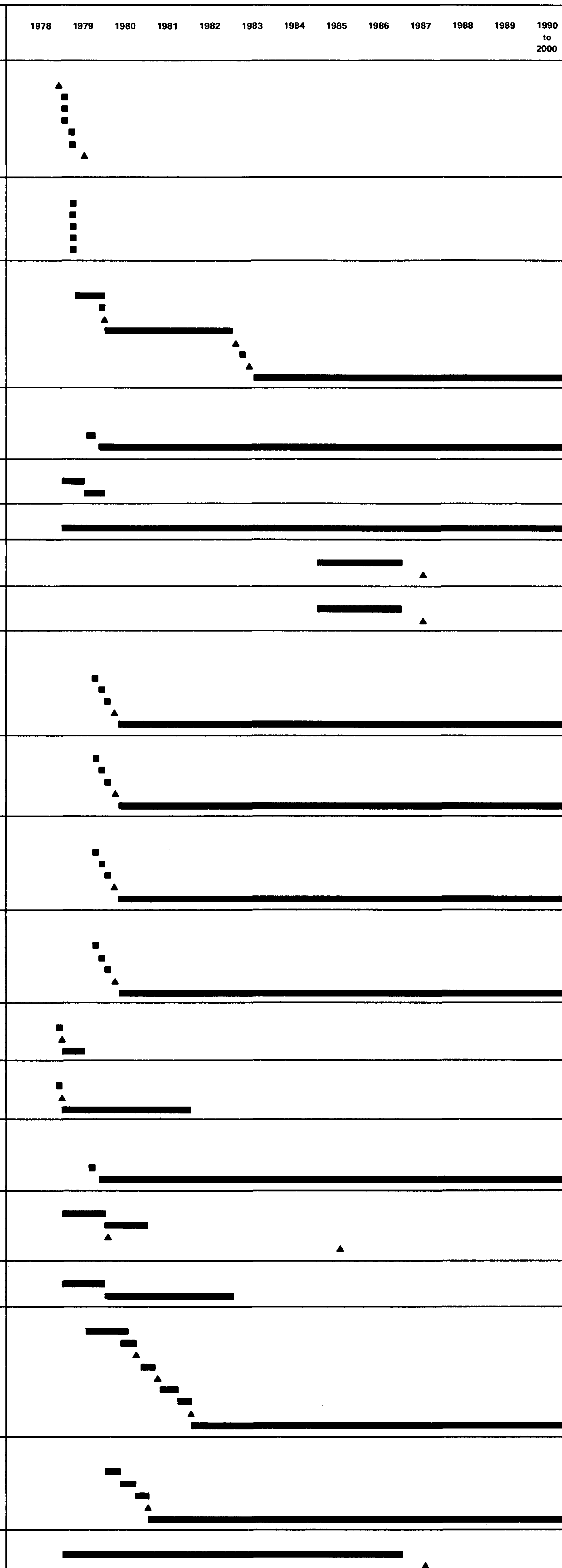
In this section Battelle has recommended three action plans that incorporate the alternative energy strategies--A (minimum), B (moderate), C (maximum)--as defined in the previous section. Each plan contains a list of actions required to implement the conservation, supply, and institutional options as well as the administrative actions required to organize and prepare for technical implementation. Various research actions required for further feasibility analysis, demonstration, monitoring, and evaluation are also included.

The Action Plan is presented in the format of a time schedule (Table 50). Some actions take only a short time to implement and complete, such as the establishment of the City Energy Coordinator. Others, such as the integrated utility system based on gasification of coal and municipal refuse, may require several years to implement because of the need for further feasibility analysis, demonstration, planning, and construction. It should be understood that once implemented, some of the actions are expected to carry on to the year 2000 in order to achieve the estimated benefits in energy savings and reduction in use of scarce fossil fuels.

Certain actions can be implemented and completed without further research. The Action Plan identifies those actions that can be implemented by the City of Riverside in addition to those actions that require additional research and/or demonstration.

TABLE 50. RECOMMENDED ACTION PLAN FOR IMPLEMENTATION FOR SELECTED ALTERNATE ENERGY STRATEGIES

Action	Responsibility/ Activity	Strategy A	Strategy B	Strategy C
Organization for Implementation				
(a) Appointment of energy coordinator	C	X	X	X
(b) Evaluation of Battelle recommendations	C	X	X	X
(c) Selection of alternative energy strategy	C	X	X	X
(d) Develop public education program, if needed	C/R	X	X	X
(e) Public meetings, if needed	C	X	X	X
(f) Modify alternative energy strategy	C	X	X	X
(g) Adoption of final alternative energy strategy by City Council	C	X	X	X
Optimum Administration of State Energy Code				
(a) Assess present manpower	C	X	X	X
(b) Acquire additional staff, if needed	C	X	X	X
(c) Evaluate knowledge and understanding of staff	C	X	X	X
(d) Conduct additional training	C	X	X	X
(e) Provide information to construction industry	C	X	X	X
Develop and Implement a Land Use Policy Emphasizing Concentrated Planned Neighborhood Development				
(a) Feasibility analysis	R	X	X	X
(b) Develop tentative policy	C	X	X	X
(c) Adopt tentative policy	C	X	X	X
(d) Conduct demonstration	C/R	X	X	X
(e) Go/no go decision	C	X	X	X
(f) Modify policy, if necessary	C	X	X	X
(g) Adopt policy	C	X	X	X
(h) Implement policy	C	X	X	X
Develop and Implement Continuing Education Program to Improve the Efficiency of Industrial Processes and Operations in Small Industry				
(a) Develop educational program	C/R	X	X	X
(b) Implement educational program	C	X	X	X
Solar Water and Space Heating				
(a) Design educational program for general public	C/R	X	X	X
(b) Implement educational program	C	X	X	X
Investment in Remote Conventional Generating Plants				
(a) Execute according to previous studies	C	X	X	X
Investment in Remote Nonconventional Generating Plants				
(a) Conduct cost/feasibility study	R	X	X	X
(b) Investment decision point	C	X	X	X
Integrated Utility System				
(a) Conduct cost/feasibility study	R	X	X	X
(b) Investment decision point	C	X	X	X
Develop and Supplement a Planning Policy to Encourage the Use of Passive Solar Building Design (Building Orientation)				
(a) Prepare draft planning policy	C/R		X	X
(b) Public review	C		X	X
(c) Modify policy, if necessary	C		X	X
(d) Adopt planning policy	C		X	X
(e) Implement planning policy	C		X	X
Develop and Implement a Solar-Based Zoning Ordinance				
(a) Prepare draft zoning ordinance	C/R		X	X
(b) Public review	C		X	X
(c) Modify zoning ordinance, if necessary	C		X	X
(d) Adopt zoning ordinance	C		X	X
(e) Implement zoning ordinance	C		X	X
Develop and Implement a Minimum Solar Winter Performance Standard				
(a) Prepare draft standard	C/R		X	X
(b) Public review	C		X	X
(c) Modify standard, if necessary	C		X	X
(d) Adopt standard	C		X	X
(e) Implement standard	C		X	X
Develop and Supplement a Minimum Solar Summer Performance Standard				
(a) Prepare draft standard	C/R		X	X
(b) Public review	C		X	X
(c) Modify standard, if necessary	C		X	X
(d) Adopt standard	C		X	X
(e) Implement standard	C		X	X
Convert Incandescent Street Lights				
(a) Conduct life-cycle cost analysis	C/R		X	X
(b) Select lamp type	C/R		X	X
(c) Convert lights	C		X	X
Reduce Total Energy Demand in Street Lighting Systems				
(a) Conduct life-cycle cost analysis	C/R		X	X
(b) Select final strategy	C/R		X	X
(c) Make conversion	C		X	X
Develop and Implement Continuing Education Program on Vanpooling, Carpooling, Purchasing of Fuel-Efficient Vehicles, Driving Efficiencies				
(a) Develop educational program	C/R		X	X
(b) Implement educational program	C		X	X
Hydrogen Production for Captive Fleet				
(a) Conduct feasibility study	R		X	X
(b) Purchase hydrogen generator	C		X	X
(c) Begin converting fleet	C		X	X
(d) Complete fleet conversion	C		X	X
Methane From Wastes				
(a) Conduct design study	R		X	X
(b) Implement plants	C		X	X
Develop and Implement a Building Retrofit Code				
(a) Feasibility analysis	R			X
(b) Develop draft code	C			X
(c) Adopt draft code	C			X
(d) Conduct demonstration	C/R			X
(e) Go/no go decision	C			X
(f) Public review	C			X
(g) Modify code, if necessary	C			X
(h) Adopt code	C			X
(i) Implement code	C			X
Develop and Implement Land Use Policy to Modify the Existing Housing Mix				
(a) Prepare draft policy	C/R			X
(b) Public review	C			X
(c) Modify policy, if necessary	C			X
(d) Adopt policy	C			X
(e) Implement policy	C			X
Geothermal District Heating System				
(a) Conduct feasibility study	R			X
(b) Investment decision point	C			X



REFERENCES AND NOTES TO VOLUME 1

(1) Riverside Chamber of Commerce booklet, "Why did Captain Juan Bantista de Anza Return to Riverside, California?", containing:

- A map of Southern California
- The history of Riverside
- A roster of Chamber members
- Aerial photographs of the Industrial Parks in the City.

(2) Riverside Planning Department, "Summary of the 1970 Census Data for Riverside, California", including:

- Statistics for the City
- A census tract/community map.

(3) ASHRAE Handbook of Fundamentals, 1972, American Society of Heating, Refrigeration and Airconditioning Engineers.

(4) National Oceanic and Atmospheric Administration, Climatological Data--California, Vol. 76, No. 1, January, 1972, through Vol. 80, No. 12, December, 1976, CIAES 7700054.

(5) W. A. Beckman, S. A. Klein, J. A. Duffie, Solar Heating Design by the F-Chart Method, John Wiley & Sons (1977).

(6) Phone calls to University of California at Riverside Weatherside Service, Mr. Willis Huxman, November 15, 1977.

(7) 1970 Census Data--California, Detailed Housing Characteristics: Fuels and Appliances for Areas and Places.

(8) Interruptible customers pay a lower rate than firm customers at the expense of being the first to be cut off from service in the event of a curtailment.

(9) Letter request for energy consumption data were sent to 61 of the industrial customers in Riverside. A list of the largest electrical energy consumers was obtained from C. E. Dole, Jr., Executive Director of the Economic Development Division of the Chamber of Commerce. Additional industries were selected from a County Department of Development publication entitled "Directory of Manufacturers--1978". This directory included product listings, the number of employees, and the total square footage.

The initial meager response to the first letter, September 30, 1977, prompted a second letter on December 12, 1977. A total of 14 responses, to the 61 letters sent, were received.

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(10) Southern California Edison Company, "Electrical Energy and Demand Data for the City of Riverside--January, 1950 through May, 1977", CIAES 7700042.

(11) Riverside Public Utilities Department, "Electrical Consumption by Sector--1971 through 1976", J. Westmorland, letter dated November 3, 1977.

(12) Southern California Gas Company, "National Gas Consumption for the City of Riverside--1966 through 1976", CIAES 770044.

(13) Electric peak demand data were available through the Riverside Public Utilities Department. Comparisons of summer and winter peak demand charts established the component of peak demand attributable to electric space cooling applications. The following assumptions aided in distributing the peak demand among the consuming sectors:

   (a) Weekday afternoon peaks were attributable to residental, commercial, and industrial consumption.

   (b) Sunday afternoon peaks were attributable to residential and commercial consumption.

   (c) Sunday evening peaks were attributable to residential consumption.

The term "Thermal Energy" is fully explained in the text under "Current Trends in Energy Consumption--Energy Matrix". Estimates of the peak thermal demand were arrived at by:

- Extrapolation of the least-squares linear correlations of natural gas consumption versus heating degree days to an ASHRAE design day (8).
- Assuming a peak furnace and boiler conversion efficiency of 80 percent fot the space heating component of natural gas consumption.
- Assuming the following saturation levels:

  --93 percent of homes have gas space heating(12)
  --95 percent of all homes are occupied(18).

- Assuming natural gas contains 1,050 Btu/Cu ft (19).

(14) Census Tract Areas, obtained by planimetering map (36):

REFERENCES
(Continued)

Census Tract	Area (sq mi)	Census Tract	Area (sq mi)
301	1.7	315.01	1.0
302	1.7	315.02	1.0
303	1.1	316	1.4
304	0.7	317	9.4
305	1.3	409	4.2
306	8.3	410	3.2
307	0.8	411	1.5
308	2.0	412	1.8
309	2.4	413	1.4
310	1.2	414.01	3.3
311	1.1	414.02	0.8
312	1.5	422.01	8.4
313	0.9	422.02	1.6
314.01	0.8	422.03	2.6
314.02	0.8	423	2.8
Total			72.4

(15) The residential distribution of energy characteristics to each census tract was achieved by: (1) calculating from the consumption data (14, 15, 16) the energy characteristics of individual dwelling units; (2) using the available dwelling unit estimated (2,18) to establish the number of dwelling units per census tract. The final energy characteristics for the individual types of dwelling units are:

Residential Unit Demands

	Thermal (Btuh/unit)			Electrical (kW)unit)		
	Peak Demand	Average Usage	Base Load	Peak Demand	Average Usage	Base Load
Single Family	23,800	6500	4600	2.2	0.43	0.50
Multifamily	16,900	4600	4600	1.6	0.30	0.50
Mobile Home	15,200	4000	.600	1.4	0.27	0.50

(16) Since the industrial distribution of energy to the census tracts could not be obtained through individual letter requests (13), another approach was taken. From Reference (1), the Riverside telephone directory and a street map of the city (29), the 61 industries were collected into their respective census tracts. Requests were then made to Southern California Gas Company and the Riverside Public Utilities Department to tabulate the total monthly energy consumption of each census tract grouping for 12 months. In this way, the industrial consumption distribution by census tract was obtained without revealing any priviledged information, such as the energy consumption of any one industry.

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(Continued)

(17) A "Map of Shopping Centers and Retail Areas in Riverside" compiled by the Chamber of Commerce provided the location of the 26 large commercial areas in the city. A letter from the energy coordinator for this project, dated 12/19/77, ranked the size of these areas on a scale from 1 to 5. From this, a percentage distribution of the total commercial consumption to each census tract was derived. These percentages were altered to include:

(a) A blanket 15 percent distribution of the total commercial consumption to the entire city to account for the numerous small shops scattered throughout the city.

(b) The largest known commercial consumers, which were not included on the Chamber map: City Hall, La Sierra College, Riverside County Hospital, Riverside Community Hospital, and the University of California at Riverside.

(18) Date from "Prepared Testimony of Bill F. Roberts, dated June 15, 1977, for the State Energy Resources Conservation and Development Commission of the State of California Docket No. 76-NOI-2", pp b-27 to b-34, Section entitled "Conservation Savings from Title 24 Building Standards".

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(22) Data supplied by Mr. H. D. Boen, Physical Plant Administrator, University of California, Riverside.

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