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WORK PLAN FOR COMPLETING A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT

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Work Plan for Completing a Technology Assessment of Western Energy Resource Development

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Energy from the West

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FOREWORD

The production of electricity and fossil fuels inevitably creates adverse impacts on Man and his environment. The nature of these impacts must be thoroughly understood if balanced judgments concerning future energy development in the United States are to be made. The Office of Energy, Minerals, and Industry (OEMI), in its role as coordinator of the Federal Energy/Environment Research and Development Program, is responsible for producing the information on health and ecological effects - and methods for mitigating the adverse effects - that is critical to developing the Nation's environmental and energy policy. OEMI's Integrated Assessment Program combines the results of research projects within the Energy/Environment Program with research on the socioeconomic and political/institutional aspects of energy development, and conducts policy - oriented studies to identify the tradeoffs among alternative energy technologies, development patterns, and impact mitigation measures.

The Integrated Assessment Program has utilized the methodology of Technology Assessment (TA) in fulfilling its mission. The Program is currently sponsoring a number of TA's which explore the impact of future energy development on both a nationwide and a regional scale. For instance, the Program is conducting national assessments of future development of the electric utility industry and of advanced coal technologies (such as fluidized bed combustion). Also, the Program is conducting assessments concerned with multiple-resource development in three "energy resource areas":

- Western coal states
- Lower Ohio River Basin
- Appalachia

This report represents a work plan for completing the final phase of the Western assessment. This phase involves conducting extensive analysis of alternatives for eliminating or reducing adverse impacts of energy development, and completing impact assessment work begun in the first phase of the project.

Steven R. Reznek
Acting Deputy Assistant Administrator
for Energy, Minerals, and Industry

PREFACE

This is a Work Plan for completing a "Technology Assessment of Western Energy Resource Development" being conducted by an interdisciplinary research team from the Science and Public Policy Program (S&PP) of the University of Oklahoma for the Office of Energy, Minerals and Industry (OEMI), Office of Research and Development, U.S. Environmental Protection Agency (EPA) under contract No. 68-01-1916. This technology assessment (TA) is one of several being conducted under the Integrated Assessment Program established by OEMI in 1975. Recommended by an interagency task force, the purpose of the Program is to identify economically, environmentally, and socially acceptable energy development alternatives. The overall purposes of this particular TA are to identify and analyze a broad range of consequences of energy resource development in the western U.S. and to evaluate and compare alternative courses of action for enhancing desirable consequences and mitigating or eliminating undesirable ones.

The development of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in an eight-state area (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming) is to be assessed. The time frame for the assessment is the period 1975 to 2000; however, selected impacts resulting from shutting down energy developments beyond 2000 are also analyzed.

The Project Director is Irvin L. (Jack) White, Assistant Director of S&PP and Professor of Political Science at the University of Oklahoma. Steven E. Plotkin, Office of Energy, Minerals and Industry, in EPA's Office of Research and Development, is the EPA Project Officer. Michael A. Chartock, Assistant Professor of Zoology and Research Fellow in S&PP, and R. Leon Leonard, Associate Professor of Aeronautical, Mechanical, and Nuclear Engineering and Research Fellow in S&PP, are Co-Directors of the research team. S&PP team members are: Steven C. Ballard, Visiting Assistant Professor of Political Science; Martha W. Gilliland, Systems Ecologist; Edward J. Malecki, Assistant Professor of Geography; Edward B. Rappaport, Visiting Assistant Professor of Economics; Timothy A. Hall, Graduate Research Assistant (Political Science), Gary D. Miller, Graduate Research Assistant (Civil Engineering and Environmental Sciences); Frank J. Calzonetti, Graduate Research Assistant (Geography); and Mark S. Eckert, Graduate Research Assistant (Geography). Professors Ballard, Malecki, and Rappaport are also Research Fellows in S&PP.

Three subcontractors are assisting in the completion of the study: Radian Corporation, Austin, Texas; Water Purification Associates, Cambridge, Massachusetts; and the Federation of Rocky Mountain States, Denver, Colorado.

This Work Plan supplements and extends, Irvin L. White, et al., First Year Work Plan for a Technology Assessment of Western Energy Resource Development.[1] Extensions and refinements to the impact analyses described in that report are described in Chapter 2; policy analyses, the major focus of the final year of the study, are described in Chapter 3.

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[1]White, Irvin L., et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976.

ABSTRACT

This is a Work Plan for completing a three-year technology assessment of the development of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah and Wyoming). The time period covered by the study is 1975-2000. The five chapters of the Work Plan describe: (1) the study and its objectives; (2) the impact analyses to be conducted to extend and refine impact analyses results reported in Irvin L. White, et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols. and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d); (3) how policy analyses are conducted in a technology assessment generally and in this western energy study specifically; (4) the background and supporting materials reports that are also to be published as a product of the study; (5) the final technology assessment report; (6) the timetable for completing the study; and (7) regional activities to stimulate participation and utilization. This Work Plan supplements and extends Irvin L. White, et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976.

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LIST OF ACRONYMS AND ABBREVIATIONS

BACT	best available control technology
bbl/d	barrel(s) per day
$CaCO_3$	calcium carbonate
EPA	Environmental Protection Agency
ERDS	Energy Resource Development System(s)
ESP	electrostatic precipitator
FPC	Federal Power Commission
mg/ℓ	milligrams per liter
MMtpy	million tons per year
MWe	megawatt-electric
NSD	Non-Significant Deterioration
OEMI	Office of Energy, Minerals and Industry
PSD	Prevention of Significant Deterioration
RFP	request for proposal
SEAM	Surface Environment and Mining Program
SEAS	Strategic Environmental Assessment System
SO_2	sulfur dioxide
S&PP	Science and Public Policy Program
SRI	Stanford Research Institute
TA	technology assessment
TSP	total suspended particulate
WPA	Water Purification Associates

ACKNOWLEDGEMENTS

The research reported here could not have been completed without the assistance of a dedicated administrative support staff. In a very real sense, these persons are an integral part of the interdisciplinary team approach to technology assessment described in the report. This staff is headed by Janice K. Whinery, Project Specialist, and includes: Sharon S. Pursel, Clerical Supervisor; Karen M. Hammers, Mary L. Bell, Brenda Skaggs, and Ellen Ladd, secretaries; Martha Jordan, Head Research Team Assistant; David Sage and Thomas Young, Research Team Assistants. Kathy Stephenson and Sheila Peterson contributed at an earlier stage of preparation of this report. Nancy Ballard designed the title page.

An Advisory Committee, several consultants and subcontractors have assisted the team. The names of the members of the Advisory Committee, consultants, and subcontractors are listed separately below. Others who have assisted are too numerous to list here. Needless to say, no member of the Advisory Committee, consultant, subcontractor or any other individual or agency is responsible for the content of this Work Plan. The Work Plan is the sole responsibility of the interdisciplinary research team conducting this study.

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CHAPTER 1

BACKGROUND AND ORGANIZATION

1.1 INTRODUCTION

In March, 1975, the U.S. Environmental Protection Agency (EPA) issued a request for proposal (RFP) for "A Technology Assessment of Western Energy Resource Development." Given a national policy of reducing dependence on energy imports, the substantial and diverse energy resources located in the western U.S. make it a prime candidate for rapid large-scale energy development. In fact, energy development plans already announced for the region make large-scale development appear imminent. EPA's RFP was largely motivated by recognition that development of the region's energy resources will inevitably produce a broad range of economic, social, environmental, and institutional consequences, not only locally, but nationally and internationally as well.

As stated in the RFP, EPA's purpose is to have an integrated assessment of alternative energy resource development activities, facilities, and operations in the western U.S. (excluding offshore and Alaskan activities) performed. This assessment is to go beyond a traditional examination of primary impacts by identifying and, to the extent feasible, quantifying "interactions, side effects, spillovers, and tradeoffs among several energy technologies and other aspects of living."[1] EPA indicated that the results of this 36-month assessment would be used to help the agency develop its environmental control policies and implementation strategies as they apply to western energy resource development.

Beginning with the proposal submitted in response to EPA's RFP, the Science and Public Policy Program (S&PP) interdisciplinary research team has assumed that the achievement of EPA's purpose requires the assessment of impacts and policies at all jurisdictional levels ranging from local to national. EPA has agreed with this broad interpretation and with the more general restatement of the overall purposes of the project. These are to: (1) identify a broad range of consequences likely to result from

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[1]Quoted by EPA from Kiefer, David M. "Technology Assessment." Chemical Engineering News, Vol. 48 (October 5, 1970), pp. 42-56.

various patterns, rates, and levels of development of six energy resources in eight western states; and (2) identify, evaluate, and compare alternative policies and implementation strategies for dealing with these consequences.[1] The six resources are coal, geothermal, natural gas, oil, oil shale, and uranium.[2] The eight states are Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah and Wyoming. Coal resource development receives more attention than does the development of the other five resources.[3]

Despite the broad interpretation of what is required to achieve EPA's purposes, the assessment is structured to be responsive to EPA's charge that the study team produce results that can be used to help the agency develop and/or modify its environmental control policies, programs, and implementation strategies. For example, although EPA needs to be broadly informed concerning local, state, and regional problems in order to insure that its own program for dealing with these same impacts are responsive and effective, the S&PP interdisciplinary research team will not attempt to perform a detailed analysis of alternative policies and implementation strategies for each of these levels of government. However, in some cases such as water rights and air quality standards, other levels of government are so intimately involved in dealing with impacts that the problems for these levels of government will have to be analyzed in some detail. Three criteria are used to determine which problems and issues are to be analyzed in detail. The three are: does EPA have responsibility and

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[1]It is beyond the scope of this study to analyze the "driving forces" that will affect the levels and patterns of development that take place. Our more limited purpose is to provide information on the consequences that can be expected if various levels and patterns of development do take place. However, our progress report, Energy From the West, briefly discusses some of these driving forces; and our final report to EPA will also discuss these forces and how they have, are, and may affect the development of western energy resources. See White, Irvin L., et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols. and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d)

[2]Other energy resources such as solar are excluded. Their development can, of course, affect the development of these six resources. However, the purpose of this study is not to forecast levels of development but to determine the likely consequences of several levels and patterns of development.

[3]Coal is emphasized because of its short- to mid-term importance in current and proposed policies, the large quantities of it that are present in the study area, and the numerous ways that it can be used.

authority for dealing with the problem or issue (for example, problems and issues arising as a consequence of air and water quality impacts); does the problem or issue affect or are they affected by existing EPA policies and programs (for example, the discharge of water effluents into on-site holding ponds, though currently viewed by EPA as being outside its jurisdiction, may affect surface and ground water quality); and is the duration, magnitude, or seriousness of the problem or issue so great that the future of western energy resource development might be affected? (For example, some local planning and growth management problems such as the timing and distribution of revenues for providing community services and facilities may have this effect.)

In applying all three criteria, members of the interdisciplinary research team will exercise their collective best judgment particularly in applying the third criterion.[1] Extensive external review by EPA, other federal agencies, state and local officials, and a broad range of parties interested in western energy resource development will provide a check on the team's choices. This external review process, a key element in S&PP's approach to technology assessment, is described in Chapter 5 of the initial Work Plan for this project.[2]

1.2 PROGRESS TO DATE

Two reports have been published by the team to date: a First Year Work Plan for a Technology Assessment of Western Energy Resource Development;[3] and Energy From the West: A Progress

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[1]As several reviewers of a draft of this Work Plan have noted, trusting the judgment of the interdisciplinary core team is an essential and inescapable element in this approach. We agree. This is why we submit the team's research products to such extensive external critical review by both substantive experts and representatives of the broad range of interests and values that are at stake. A major reason for this extensive external review process is to insure that the team's collective expertise, judgment, biases, and limits in perspective are identified, evaluated, and taken into account. This helps potential users of the team's research product to decide whether the team should be trusted and to establish the team's credibility.

[2]White, Irvin L., et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976. (EPA-600/5-76-001, NTIS order #PB-252 034/AS)

[3]Ibid.

Report of a Technology Assessment of Western Energy Resource Development.[1] The First Year Work Plan describes the team's approach and conceptual framework. Impact analysis categories, methods, and procedures are also described; and the team's approach and procedures for policy analysis are briefly outlined.

Energy From the West presents the results of analyses completed during the first phase of the project. Although the team's initial emphasis on impact analysis is reflected in this progress report, the results of preliminary efforts to identify and define selected policy problems and issues are also reported.

The S&PP research team, Radian, and other subcontractors have produced several other products. These include draft energy resource development systems (ERDS)[2] descriptions for the six resources being studied. As discussed in the First Year Work Plan, the primary purpose of the ERDS is to describe the technologies, their input requirements, their outputs, and the federal and state rules and regulations that control their use.[3] These ERDS contain baseline data that were required before impact analyses could begin.[4] Technology descriptions for all six resource systems have been completed and are being reviewed by experts in industry, government, universities, and research companies. The required data on federal and state rules and regulations have been integrated into the descriptions of the technologies. This ERDS report will be distributed in early 1978.

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[1]White, Irvin L., et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols., and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d)

[2]White, Irvin L., et al. Energy Resource Development Systems for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, forthcoming.

[3]Rules and regulations for only the eight states in our study area are included. As indicated earlier, the eight are: Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming.

[4]The ERDS did provide the required baseline data. However for the ERDS report to serve its intended function as a reference book for planning, additional data have been added. Adding these data has delayed publication. The ERDS draw from a number of previous reports including: University of Oklahoma, Science and Public Policy Program. Energy Alternatives: A Comparative Analysis. Washington, D.C.: Government Printing Office, 1975; and Radian Corporation. A Western Regional Energy Development Study, 3 vols. and summary. Austin, Texas: Radian Corporation, 1975.

Two reports have been prepared by subcontractors. The first, prepared by Michael Rieber and Shao Lee Soo of the Center for Advanced Computation at the University of Illinois at Urbana-Champaign, reports the results of an analysis of Route Specific Cost Comparisons: Unit Trains, Coal Slurry Pipelines and Extra High Voltage Transmission.[1] The second, a report of Water Requirements for Steam-Electric Power Generation and Synthetic Fuel Plants in the Western United States, was prepared by Water Purification Associates of Cambridge, Massachusetts.[2]

A report entitled Scenario Run Analysis: Western Energy Development[3] describes the analysis of three western energy development scenarios used in the regional and national economic and materials and equipment analyses reported in Energy From the West. The three scenarios were analyzed using EPA's Strategic Environmental Analysis System (SEAS). Prepared by Control Data Corporation and International Research and Technology Corporation for the Technical Information Division of EPA's Office of Research and Development, this report is available as a separate contractor's report.

A separate data and research adequacy report is also being prepared by the S&PP research team. This report, which will focus on the problem of making policy choices under conditions of uncertainty and which will identify data and research inadequacies that affect the project, is expected to be distributed before June 30, 1978.

Under a subcontract with the University of Oklahoma, the Federation of Rocky Mountain States is conducting a planning study that emphasizes differences in planning for permanent and temporary growth. The reason for this emphasis is that many of the rural areas and small towns in the West that will experience energy development booms cannot expect to remain viable centers

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[1]Rieber, Michael, and Shao Lee Soo. Route Specific Cost Comparisons: Unit Trains, Coal Slurry Pipelines and Extra High Voltage Transmission, CAC Document No. 190. Urbana, Ill.: University of Illinois at Urbana-Champaign, Center for Advanced Computation, 1976. This report is reprinted as Appendix B in Volume IV of Energy From the West.

[2]Gold, Harris, et al. Water Requirements for Steam-Electric Power Generation and Synthetic Fuel Plants in the Western United States. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-037)

[3]Control Data Corporation and International Research and Technology Corporation. Scenario Run Analysis: Western Energy Development. Washington, D.C.: U.S. Environmental Protection Agency, Technical Information Division, 1977.

of economic activity after energy development ceases. The Federation's report will also be available before June 30, 1978.

Under another subcontract, Princeton University is conducting an analysis of facility siting policies. The Princeton effort is intended to build on previous theoretical work in dimensional analysis and the theory of growth poles and to provide a critique of the results of the research team's impact and sensitivity analyses.

1.3 PURPOSE AND ORGANIZATION OF THIS WORK PLAN

This draft work plan identifies and describes the research to be conducted during the remainder of the project. While the major emphasis will be on policy analysis and producing a final technology assessment report, impact analyses will be refined and extended, and a number of background and supporting materials will be completed and packaged for distribution. The identification and description of tasks and products to be described in this Work Plan are: (1) impact analyses; (2) policy analyses; (3) background and supporting analyses; and (4) the final technology assessment report. Additional sections describe the timetable for completing these tasks and producing reports, and briefly outline our preliminary plans to encourage the utilization of the S&PP interdisciplinary research team's research products.

CHAPTER 2

IMPACT ANALYSIS

2.1 INTRODUCTION

Impact analysis was emphasized by the Science and Public Policy-Radian research team during the first year of the study. As described in the First Year Work Plan[1] and Energy From the West,[2] seven scenarios postulating hypothetical patterns of energy development in the western U.S. were used to structure the impact analyses that were conducted. Six of the seven scenarios call for developing one or more energy resource at specific sites using specified combinations of technological alternatives. The seventh specifies three levels of energy development in the eight-state study area from the present to 2000.[3]

In constructing the site-specific scenarios, locations were selected to be representative of the range of conditions that exist where energy resources are located in the eight-state study area; and energy development technologies were selected to be representative of those expected to be used in developing energy resources in the western U.S. between now and the year 2000.

The analyses of site-specific impacts are not intended to produce environmental impact statements for specific development

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[1]White, Irvin L., et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976. (EPA-600/5-76-001, NTIS Order #PB-252 034/AS)

[2]White, Irvin L., et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols. and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d)

[3]Stanford Research Institute's energy model was used to establish the three levels of development. See Cazalet, Edward, et al. A Western Regional Energy Development Study: Economics, Final Report, 2 vols. Menlo Park, Calif.: Stanford Research Institute, 1976. These three levels and how they were adapted for this project are described in detail in Energy From the West. See also Section 2.2 below.

projects; rather the technology-site combinations chosen are hypothetical and are intended to provide a basis for formulating generalizations about local impacts and identifying variations in impacts between and among technologies, sites, and combinations of technologies and sites. Together the site-specific and eight-state scenarios provide for the analysis of a range of technological and locational alternatives, impacts, and alternative policies and implementation strategies associated with various patterns, rates, and levels of energy development within the eight-state study area.

Four categories of impacts were analyzed for each of the six site-specific scenarios: air; water; social/economic/political; and ecological. Health effects, noise, transportation, and aesthetics categories were added for the eight-state area scenario.

As the summary of results in Chapter 3 of Energy From the West demonstrates, the Science and Public Policy (S&PP) interdisciplinary research team has made considerable progress toward achieving the objectives of formulating informed generalizations about the impacts of development and identifying the variations in technologies, sites, and technology-site combinations which appear to play an important role in determining relative costs, risks, and benefits. However, the impact analyses performed to date are incomplete. These analyses must be extended and refined to support the policy analysis purposes of the study better. In the following sections of this chapter, anticipated changes in the impact analyses will be discussed under five headings: levels of development; extensions and refinements; interactive effects; uncertainty; and reporting the results of the impact analyses. Obviously the changes discussed under these five headings do not exhaust the changes that either could or ideally should be made. In making choices, the relative adequacy of completed analyses, relative significance of the impact category, likely benefits of additional analysis, particularly for policy analysis, and personnel and financial resource limitations have been taken into account. Our overall purpose has been to produce the impact analysis results needed to inform the policy analyses that will be the S&PP interdisciplinary research team's principal research activity in completing the project.

2.2 LEVELS OF DEVELOPMENT

As described in Energy From the West, the three levels of energy development postulated for our eight-state study area were based on the energy model developed for Gulf Oil Corporation by Stanford Research Institute (SRI).[1] The three levels are SRI's

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[1]For a description of the model, see Cazalet, Edward, et al. A Western Regional Energy Development Study: Economics, Final Report, 2 vols. Menlo Park, CA: Stanford Research Institute, 1976.

Low Demand, Nominal, and Low Nuclear Availability cases. In the final impact analysis report, only the Low Demand and Nominal case levels of development will be considered for coal, oil, natural gas, and uranium. Oil shale development will be modified for both cases by lowering the levels of development below those called for by the model. Geothermal resources are not included in the model and levels of development will be forecast to provide a basis for determining and analyzing the impacts of the development of these resources.

2.2.1 Coal

The Low Demand and Nominal Cases call, respectively, for 970 million and 1,150 million tons of coal to be produced nationally in 1985. Without a change in current policies, the Administration's National Energy Plan[1] would require production of approximately 1,080 million tons in 1985. However the Plan proposes policy changes which would have the net effect of boosting national coal production in 1985 to about 1,280 million tons per year (MMtpy).

The Plan includes a "best available control technology" (BACT) requirement which could be expected to shift coal production away from the West since requiring all coal-fired power plants to be equipped with scrubbers[2] would largely eliminate the advantage of using low sulfur western coal in most regions of the country.[3] The <u>Montana University Coal Demand Study</u>[4] indicates that the demand for Northern Great Plains coal could decrease by as much as a third if such stringent environmental control policies were implemented.[5] This decrease would be equivalent to a

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[1]U.S. Executive Office of the President, Energy Policy and Planning. <u>The National Energy Plan</u>. Washington, D.C.: Government Printing Office, 1977.

[2]"Best available control technology" (BACT) is widely interpreted as requiring sulfur scrubbers, at least in the short run. The BACT requirement is included in the Clean Air Act Amendments of 1977. (91 Stat. 700)

[3]Kirschten, J. Dicken. "Converting to Coal--Can It Be Done Cleanly?" <u>National Journal Reports</u>, Vol. 9 (May 21, 1977), pp. 781-84.

[4]Power, Thomas M., <u>et al</u>. <u>Montana University Coal Demand Study: Projections of Northern Great Plains Coal Mining and Energy Conversion Development, 1975-2000 A.D.</u>, Final Report. Missoula, Mont.: University of Montana, 1975.

[5]Summarized in Duffield, John, <u>et al</u>. "Defining the Market for Northern Great Plains Coal." <u>Montana Business Quarterly</u>, Vol. 14 (Summer 1976), pp. 18-25.

national demand of 850 million tons in 1985 which is slightly less than SRI's Low Demand case. SRI's national projections for 1990 are 1,000 MMtpy and 1,260 MMtpy for the Low Demand and Nominal cases. This would require that 580 MMtpy and 740 MMtpy respectively be produced in the West.

Projected national production for the year 2000 is 2,000 MMtpy (Low Demand case) and 2,640 MMtpy (Nominal case). Production in the West would be 1,300 MMtpy and 1,760 MMtpy respectively. This leads us to conclude that SRI's Low Demand and Nominal cases will continue to be reasonable bases for determining and analyzing impacts.

2.2.2 Oil Shale

The SRI Low Demand and Nominal cases call for five 100,000 barrels per day (bbl/d) oil shale facilities by 1990 and 35 facilities (Low Demand) and 42 facilities (Nominal) by 2000. These forecasts now appear to be too high. The commercial oil shale developments that were expected in the mid-1970's failed to materialize. The only oil shale development plans that have been approved by the Secretary of the Interior are Occidental and Ashland's *in situ* development at Colorado Tract B and a smaller project by Gulf and Standard (Indiana) at Colorado Tract A. Together these developments could produce 62,000 bbl/d of shale oil by 1983.[1] Other developments may occur, including a federally sponsored 100,000 bbl/d surface retort. However, the required lead times make it unlikely that the level of development will exceed the following:

1990-- 2 levels: 1 and 5 100,000 bbl/d facilities

2000-- 3 levels: 10, 25, and 42 100,000 bbl/d facilities

2.2.3 Oil, Natural Gas, Uranium, and Geothermal

The levels of development for oil, natural gas, and uranium called for by SRI's Low Demand and Nominal cases[2] still appear to be a reasonable basis for determining and analyzing the impacts

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[1]Occidental and Ashland's *in situ* development would produce 57,000 barrels/day of this total.

[2]The levels for each are:

	1990		2000	
	Low Demand	Nominal	Low Demand	Nominal
Oil (million barrels/day)	.60	.45	.60	.50
Natural Gas (billion cubic feet/day)	5.2	3.2	3.2	3.0
Uranium (thousand tons/day yellowcake)	28.8	51.3	37.8	71.1

of energy resource development in the western U.S. As noted above, geothermal resources are not included in SRI's model. Taking into account announced plans and assuming a national production level of geothermal-based electric power of 2,500 to 5,000 megawatts in 1985 and 7,000 to 50,000 in 2000, it seems reasonable to forecast the development of 100 to 200 megawatts by 1985 and 700 to 5,000 by 2000 in the eight-state study area.[1] The 100 to 200 megawatts are based on planned developments in the Jemez Mountains in New Mexico and in the vicinity of Roosevelt, Utah. The 700 to 5,000 megawatts is 10 percent of the level of national production estimated for 2000. This is approximately the percentage of U.S. geothermal resources located in the eight-state area.

2.3 EXTENSIONS AND REFINEMENTS

In this section, the extensions and refinements that are to be made to the impact analyses reported in Energy From the West are described. These changes include: adding several additional technological alternatives; performing selected sensitivity and parametric analyses in each impact category; filling in gaps and adding to the depth of analysis in selected aspects of each impact category, revising the format for reporting results to show both impacts attributable to a particular technology and to the combination of technologies in each scenario; and summarizing the costs, risks, and benefits of development alternatives. Each of these will be discussed below.

2.3.1 Added Development Alternatives

Five energy resource development alternatives are to be added, three at specific sites (solutional uranium mining at Gillette, conventional uranium mining and milling at Navajo/Farmington, and modified in situ oil shale at Rifle) and two in the eight-state areawide scenario (enhanced oil recovery and geothermal). The uranium developments are added to approximate more closely the pattern of energy development that can be anticipated in New Mexico and to add an analysis of the impacts of solutional mining.

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[1]These are the concensus estimates from Loveland, Walter D., Bernard I. Spinrad, and C. H. Wang, eds. Magnitude and Deployment Schedule of Energy Resources; Proceedings of a Conference Held on July 21-23, 1975, in Portland, Oregon, under the Sponsorship of the Energy Research and Development Administration, Pacific Northwest Regional Commission, and Oregon State University Office of Energy Research and Development. Corvallis, OR.: Oregon State University, 1975. U.S. Energy Research and Development Administration, Division of Geothermal Energy. Definition Report: Geothermal Energy Research, Development and Demonstration Program. Springfield, VA.: National Technical Information Service, 1975 (NTIS Order #ERDA-86), estimates 1,500 to 6,000 megawatts by 1980. These estimates do not include non-electrical generating uses such as space heating and crop drying.

Modified in situ oil shale development is being added because it now appears that the first commercial scale oil shale developments will utilize this technological alternative.[1]

Enhanced oil recovery and geothermal resource development are being added to the eight-state areawide scenario to provide an analysis of the impacts of a variety of technological alternatives for developing those resources. In the case of both, the selection of technological alternatives is either reservoir or resource specific. Although it is not feasible to do a site-specific analysis of each alternative, it is possible to generalize about the impacts of deploying a range of these alternatives on an areawide basis.

A. Uranium

A uranium surface mine producing 1,100 tons of ore per day by 1985 will be added to the Navajo/Farmington scenario. This mine will be sited near Shiprock and will be scheduled to be operational in 1985.

A uranium milling facility producing 1,000 metric tons of yellowcake per year by 1985 will also be added. The mill will utilize acid leaching and ammonia precipitation processes. Yellowcake produced by the mill will be transported out of the eight-state study area.

A uranium solutional mine producing 1,000 tons of ore per day by 1985 will be added to the Gillette scenario. The uranium milling facility will be expanded to 1,000 tons of yellowcake. Data for both the surface mine and milling facility are available from the Energy Resource Development Systems for a Technology Assessment of Western Energy Resource Development (ERDS).[2] Data on solutional mining are not so readily available. However, sufficient data are expected to be available to support an analysis of the water impacts, the impacts of special interest in the case of this technological alternative.

B. In Situ Oil Shale

A 57,000 bbl/d Occidential modified in situ oil shale development will be added to the Rifle scenario. This development will be sited in the Piceance Creek Basin and is scheduled to be operational in 1982. This daily production rate is based on a full

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[1]"In Business This Week; Companies: Oil-Shale Development." Business Week, September 12, 1977, p. 52.

[2]White, Irvin L., et al. Energy Resource Development Systems for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, forthcoming.

scale development unit consisting of a room approximately 200 feet square and 310 feet high with a mined-out base of one-third acre. An estimated 1,150 barrels per acre-foot or a total of 115,000 barrels would be produced by each unit for an overall recovery of 40 percent. The in situ retorting will burn from the top of the room down with air being blown in at the top and pulled out at the bottom. Some low Btu-gas would be produced and it will be used for on-site steam generation. Shale mined in the construction of the rooms will be retorted in a surface retort. A pipeline will transport the shale oil from both the in situ and surface retorts to refineries outside the eight-state study area.

Some data problems are anticipated; however, sufficient data for determining the likely impacts of this kind of development are expected to be available from the U.S. Geological Survey Supervisor's Office in Grand Junction, Colorado, and published development plans.

C. Enhanced Oil Recovery

A variety of enhanced oil recovery techniques are either being used or tested. The most widely used method is waterflooding, a technique now commonly used very early in the productive life of a reservoir. Less commonly used techniques are polymer floods, surfactants, miscible recovery, immiscible gases, and thermal recovery. These techniques are reservoir-specific, with the choice of technique being determined by the properties of the reservoir and the viscosity of the oil. Two techniques, thermal recovery using steam flooding and carbon dioxide miscible flooding will be analyzed as the enhanced recovery processes most likely to be deployed, and the impacts likely from other technologies will be compared to these. The Office of Technology Assessment's enhanced oil recovery study is expected to provide sufficient data to permit the identification of residuals and a general characterization of the likely impacts of deploying these technologies on an areawide basis.[1]

D. Geothermal

Most of the geothermal resources likely to be developed within the eight state study area are hot-water convection systems and the analysis of the impacts of geothermal resource development in the eight-state study area will stress these. Dry hot rock systems will also be considered, but in less detail.

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[1]U.S. Congress, Office of Technology Assessment. An Assessment of Enhanced Oil Recovery Potential in the U.S., Draft Copy. Washington, D.C.: Office of Technology Assessment, 1977. The final report is expected to be available in time to be used in this analysis.

While not adequate to support a site-specific analysis, data from the ERDS, Resource Planning Associates' report on Western Energy Resources and the Environment: Geothermal,[1] and the Futures Group's technology assessment of geothermal resource development[2] should provide an adequate basis for a general characterization of areawide impacts.

2.3.2 Changes Within Impact Analysis Categories[3]

A. Air Quality

During the first year, air quality impact analyses included predictions of 3-hour, 24-hour and annual average ground level concentrations of criteria pollutants and cooling tower drift.[4] Other air quality impacts discussed more generally were sulfates, oxidants, plume opacity, and long range visibility. Several findings show that variations in the selection and configuration of energy facilities, site parameters, and various model assumptions can significantly affect the results of air impact analyses. Some of these variations have potentially significant policy implications. For example, eliminating a scrubber, lowering a stack, and not siting a facility on the highest terrain in the area could result in violation of Environmental Protection Agency's (EPA) Prevention of Significant Deterioration (PSD)[5] regulations, ambient air quality standards, changes in long-range visibility, and, under certain circumstances, concentrations of some pollutants potentially damaging to biota and humans. Given these findings and the importance of air quality issues in decisions concerning western energy development, air quality impact analyses will be emphasized during the remainder of the study, particularly

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[1]Resource Planning Associates. Western Energy Resources and the Environment: Geothermal. Washington, D.C.: U.S. Environmental Protection Agency, Office of Energy, Minerals, and Industry, 1977.

[2]The Futures Group. A Technology Assessment of Geothermal Resource Development. Gastonbury, CT: The Futures Group, 1975.

[3]Archaeological impacts have not been ignored in either Energy From the West or the following extensions and refinements. They are treated as a land use impact in both.

[4]All three time periods do not apply to all six criteria pollutants.

[5]These regulations are sometimes labeled Non-Significant Deterioration (NSD) rather than Prevention of Significant Deterioration (PSD). The term NSD was used in Energy From the West; however, PSD is the term now being used most frequently and will be used during the remainder of the study.

sensitivity and parametric analyses and attempting a more detailed analysis of sulfates and visibility effects as described below.

The variables to be singled out in sensitivity and parametric analyses are: stack heights, environmental controls, siting con-itions, plant spacing, facility size, and operating practices.

1. Stack Heights

The effect of varying stack heights on the air quality impacts of facilities sited on elevated terrain will be examined for gasification, liquefaction, and oil shale processing facilities. For each facility, a lowest stack height consistent with good engineering practice, an average or most frequently used stack height, and a highest stack height will be examined. The worst-case impact of each of the seven power plants included in our scenarios will be determined for the lowest expected stack height of 300 feet. The results of the impact analyses completed to date indicate that 4 power plants equipped with 500-foot stacks would violate Class II PSD increments (the power plants at Kaiparowits, Farmington, Rifle, and Beulah). These plants will be reexamined when configured with 1,000-foot stacks. Additional air dispersion modeling will be performed and pollutant concentration curves (3-hour and 24-hour) as a function of distance from the plant in the prevailing wind direction will be drawn.

2. Environmental Controls

The seven power plants included in the six site-specific scenarios were equipped with 80 percent efficient sulfur dioxide (SO_2) scrubbers and 99 percent efficient electrostatic precipitators (ESP). Both 95 percent efficient and "no scrubber" configurations will be modeled to determine the maximum ambient concentrations of SO_2 that can be expected; and modeling results from the analyses already completed will be scaled to determine maximum total suspended particulate (TSP) levels for both ESP and no ESP cases. For both the SO_2 and TSP analyses, downwind short-term (3-hour and 24-hour) maximum concentration curves will be drawn.

3. Siting Conditions

Air dispersion modeling results to date indicate that a TOSCO II oil shale facility and the power plant at Rifle and one power plant at Kaiparowits/Escalante would result in violations of Class II PSD increments as a result of plumes impacting elevated terrain. Existing modeling results will be used to calculate the maximum change in air quality impacts that would result from the relocation of these facilities. Downwind short-term pollutant curves will be drawn for each facility.

4. Plant Spacing

Using existing modeling results for flat terrain conditions, downwind curves of maximum short-term pollutant concentrations will be prepared for the facilities in each of the six site-specific scenarios. These curves will be used to identify potential problems resulting from the interaction of pollutants from multiple facilities.

5. Facility Size

The impact of reducing the size of power plants at Kaiparowits/Escalante, Navajo/Farmington, Rifle, and Beulah will be determined. (In the analyses that have been completed, each of these plants was found to violate Class II PSD increments.) The impact of multiples of 750 megawatt electric (MWe) power plant units will be calculated by scaling existing modeling results. In addition, the impact of multiples of 500 MWe power plants will be examined at Rifle and Kaiparowits/Escalante. (Both of these facilities were found to have plume impaction problems in the analyses that have been completed.)

6. Operating Practices

Emissions are greater during start-up and shut-down than during steady state operations. Current operating practices will be examined to determine how often plants are being shut down and started up and what the air quality consequences of these practices are.

In addition to these sensitivity and parametric analyses, the following extensions and refinements will be undertaken:

1. Short-Term Visibility

The short-term impact of adverse dispersion conditions will be determined for each scenario for 1980, 1990, and 2000. A "box-type" dispersion model will be used to predict ambient concentrations during worst stagnation conditions on an annual basis. Sulfates resulting from SO_2 emissions will be considered in the visibility predictions using a range of 1 to 10 percent conversion rates of SO_2 to sulfates.

2. Sulfates

In its "Integrated Technology Assessment of Electric Utility Energy Systems," also being funded by EPA's Office of Energy, Minerals, and Industry, Teknekron has developed a model for predicting changes in sulfate levels that can be attributed to energy facilities. Teknekron has used this model to relate power plant siting and sulfate levels in several regions of the country, but not in the West. A similar effort has been requested for our eight-state study area. If this request is granted, a detailed meteorological map will be produced and related to energy resource and energy facility locations, conversion rates, and pollutant transport times to predict changes in sulfate levels both within and outside the western region. If the Teknekron effort is not funded, the treatment of sulfates will be much less detailed. A more generalized meteorological map will be related to resource locations, several emission levels, and transport rates as a basis for making rough estimates of changes in sulfate levels.

3. Fugitive Dust

In the impact analyses already completed, it was assumed that effective dust suppression techniques would be employed. This assumption will be reexamined. The actual effectiveness of these techniques at mine sites will be determined and the quantity of dust likely to be produced will be estimated.

The extensions and refinements to the air impact analyses described above are intended to provide a basis for estimating:

- The level of environmental controls required to meet all federal and state ambient air quality standards and federal PSD increments.
- The combination of siting and meteorological conditions most likely to produce the best and worst case conditions and the probability of each occurring.
- The sites and siting relationships among facilities most likely to result in air quality problems.
- The short-term and long-range visibility reductions that can be expected.
- The changes in sulfate levels that can be anticipated both within and outside the eight-state area as a consequence of various levels and patterns of energy resource development.
- The extent to which fugitive dust is likely to result in air quality problems.
- The air quality effects of shutting down and starting up a plant.

B. Water Availability and Quality

In extending and refining impact analyses, water will receive the highest priority. Knowledge concerning these impacts and how to avoid or mitigate them will be essential to well-informed western energy resource development policymaking.

In Energy From the West, the water impact analysis sections describe the water requirements for energy facilities. These analyses will be extended and refined by: (1) performing additional water minimization work; (2) extending the analysis of regional water requirements; (3) examining the economics of water treatment; (4) characterizing the chemical composition of water effluents discharged into on-site evaporative holding ponds; (5) determining the fate and effects of chemicals discharged into on-site evaporative holding ponds; (6) comparing the water consumption numbers used in this study to water consumption numbers found in Federal Power Commission dockets, environmental impact statements, and other open literature sources, (7) analyzing tradeoffs and selected water use mixes, and (8) extending water impact analyses to the five additional energy technologies described in Section 2.3.1.

1. Water Minimization[1]

a. Under a subcontract with the University of Oklahoma, Water Purification Associates (WPA) will determine the effect of wet/dry cooling on water consumption and cooling costs for Synthane and Synthoil coal conversion processes and for steam-electric power generating plants at two representative sites (Navajo/Farmington and Beulah). For steam electric, both turbine condensers and interstage cooling for large air and hydrogen compressors will be considered. The analysis will determine: (1) the annual cost of cooling as a function of the amount of water consumed; (2) the sensitivity of annual costs to a range of amortization charges and fuel costs; (3) the cost breakdown for wet, wet/dry, and dry cooling with comparable equipment, construction, and operation; (4) the maximum water savings realizable with wet/dry cooling; and (5) the effect of off-optimum design conditions (for electric power generation only). Calculations will take into account total systems costs including operating, auxiliary, and replacement costs.

b. Agriculture

Possible water savings in agriculture will also be examined with an emphasis on alternative methods of irrigation including trickle, sprinkler, and alternate row flooding and the eradication of phreatophytes. The water savings that might be realized by shifting to less water intensive crops will also be considered.

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[1]Except for agriculture, the water minimization tasks described here extend and refine work already performed by Water Purification Associates under subcontract to the University of Oklahoma. See Gold, Harris, et al. Water Requirements for Steam-Electric Power Generation and Synthetic Fuel Plants in the Western United States. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-037)

The principal data sources for this examination will be the reports of major studies completed by Utah State University,[1] the National Water Commission,[2] The National Academy of Sciences,[3] and the Department of the Interior.[4]

2. Regional Water Requirements

WPA will also extend the present analysis of regional water requirements by examining facilities sited at some 40 to 50 locations within the eight-state study area.[5] These sites have been selected on the basis of the: (1) availability of water; (2) climate; (3) energy resource characteristics; and (4) localized residual disposal problems. For each site, WPA is to: (1) specify the cooling technology used; (2) specify the water requirements for energy development; (3) identify the technological and locational factors that can affect water consumption; (4) specify the quantity and composition of both wet and dry wastes; (5) categorize locations on the basis of the kinds and magnitudes of the water impacts that can be anticipated; (6) indicate which combinations of technologies and locations will minimize water impacts; (7) identify changes, water treatment alternatives, and control technologies that maximize water conservation and minimize residuals; and (8) categorize subareas within the eight-state study area on the basis of water consumption and water impacts.

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[1]Utah State University, Utah Water Research Laboratory. Colorado River Regional Assessment Study, prepared for National Commission on Water Quality. Logan, UT: Utah Water Research Laboratory, 1975.

[2]U.S. National Water Commission. Water Policies for the Future, Final Report to the President and to the Congress of the U.S. Washington, D.C.: Government Printing Office, 1973.

[3]National Academy of Sciences/National Research Council, Commission on International Relations, Board on Science and Technology for International Development. More Water for Arid Lands: Promising Technologies and Research Opportunities. Washington, D.C.: National Academy of Sciences, 1974.

[4]U.S. Department of the Interior, Bureau of Reclamation. Westwide Study Report on Critical Water Problems Facing the Eleven Western States. Washington, D.C.: Government Printing Office, 1975.

[5]The data basis for this task is work previously performed by WPA for EPA's Industrial Environmental Laboratory, Research Triangle Park, NC: See Water Purification Associates. Water Conservation and Pollution Control in Coal Conversion Processes. Washington, D.C.: U.S. Environmental Protection Agency, 1977 (EPA 600/7-77-065).

3. Economics of Water Treatment

WPA will calculate the cost and energy requirements of water treatment for Synthane, Lurgi, and coal-fired steam-electric power plants utilizing: (1) lake or river water of the quality available in the vicinity of each of the six site-specific scenarios; and (2) coal with varying chloride composition. The water treatment methods considered will include total water consumption ranging from a generous quantity within current practice to a minimum quantity when stringent water minimization techniques are imposed. Costs and energy requirements will be compared to total fuel costs and energy output.

Although it does not appear that treating water to discharge it into a stream is likely (since the effluent water can be used within the plant to reduce water intake requirements), WPA will estimate the cost of meeting the secondary and tertiary treatment standards established by the Federal Water Pollution Control Act Amendments of 1972.[1] This estimate will provide economic cost data needed to evaluate a policy of no on-site ponding of effluents.

4. Residual Disposal

In order to characterize the chemical composition of the water discharged into on-site evaporative holding ponds, Radian will perform the following tasks:

(a) The quantities of major residual constituents in effluent streams will be determined for each of the following processes: (1) process boiler demineralizer waste; (2) cooling treatment wastes; (3) cooling drift and leakage; (4) flue gas desulfurization; (5) bottom ash disposal; (6) fly ash disposal; and (7) coal washing. Ash reactivity will be determined for bottom ash, fly ash, and coal washing. Process condensate treatment sludge will be examined to identify major and, to the extent possible, trace constituents.

(b) Concentrations of major constituent ions in entrained water droplets in the air stream will be determined for cooling tower drift and leakage. The major residual constituents and trace elements will also be determined for venturi scrubbing dust control and disposal of spent shale for the TOSCO II process. The chemical characterization of each of these effluent streams will include detailed descriptions of the physical, chemical,

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[1]Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, 86 Stat. 816 (codified at 33 U.S.C.A. §§ 1251 et seq. (Supp. 1976).

or biological treatment methods used before the stream is discharged into the holding ponds. The physical, chemical, and biological changes in the effluent stream that occur as a result of the treatment method will be identified. The type of contaminants to be quantified are: sodium phosphate, chlorides, calcium, magnesium, sulfates, sulfites, silicon, and potassium.

(c) Each effluent stream will also be characterized at the point of discharge to the holding pond for pH, temperature, total dissolved solids (lbs/day and milligrams per liter {mg/ℓ}), total hardness (mg/ℓ as calcium carbonate {$CaCO_3$}), total suspended solids (lbs/day and mg/ℓ), and total alkalinity (mg/ℓ as $CaCO_3$). For those chemical concentrations that would be significantly increased or decreased by selecting other operational treatment procedures, an indication will be given of what these procedures are and the effect (increasing or decreasing) they will have on the chemical characteristics of the effluent stream.

(d) In addition to the major species listed above, the organic content of the effluent streams will be examined. However, this analysis will be limited to particular processes and will not be site-specific. (This is because the organic nature of the streams will be more dependent on the process and the types of controls used than on the location of the facility.) When possible, organics will be described in terms of total phenols, fatty acids, naphthas, and straight-chain hydrocarbons.

(e) When possible the trace elements in the effluent streams being examined will be quantified. This quantification will not be site-specific since the available information is not sufficiently detailed to support a quantitative description. However, a literature search will be conducted to obtain as much site-specific information on coal and water trace elements as possible. Site-specific information that applies to the sites within the eight-state study area will be reported. When it is determined that a technically sound extrapolation can be made, information will be extrapolated to other sites.

(f) The list of trace elements to be considered will include but not be limited to: arsenic, chrome (hexavalent), copper, lead, fluorides, zinc, and chromium.

(g) Other compounds of interest will also be quantified when information is available. These compounds include ammonium salts, cyanides, and sulfides.

5. On-Site Evaporative Holding Ponds

In order to determine the likely environmental fate of the chemicals identified in the analysis described in the above section on Residual Disposal and the environmental impact of the disposal of wet-solid residuals from power generation and conversion facilities, Radian will perform the following tasks:

(a) State-of-the-art holding pond design, construction and management will be described. This description will be as site and eight-state study area specific as possible. The description of clay lined ponds will include the percent and type clay, permeability, and thickness of the liner materials, thickness and stability of berms required, construction methods and maintenance practices for the liner and berms, dewatering and decanting methods, and abandonment procedures (including the application of chemical fixatives). A similar description will be given for synthetic liners. A generalized cost comparison will be made between the use of clay-lined ponds and the use of synthetic liners.

(b) The possible interaction of chemicals in the effluents and the clay liners will be investigated. Research literature values of pond sediment compositions from industrial processes similar to those anticipated to be used in the scenario will be reported and documented as values that might occur in ponds in the study area. Potential leakage rates will be estimated as a function of the liner and soil characteristics of both clay and synthetically lined ponds used as disposal sites for soluble residuals. The wet-solids residual residence time will also be considered in estimating leakage rates. Site-specific pond analyses for three sites (one each in the Northern Great Plains, Rocky Mountains, and Southwest) will be made to compare the leakage rates that can be expected. Locational factors (climate, soil characteristics, proximity to water table, etc.) that will cause differences in leakage rates will be identified and summarized.

(c) The amount of each chemical that will be in the pond at the end of 10, 20, and 30 years will be calculated assuming the pollutants remain fixed in the chemical composition in which they enter the pond. While determination of the fate of each of the chemical species in the pond is beyond the scope of this report, the pH, total alkalinity, total hardness, chemical oxygen demand, biochemical oxygen demand, total dissolved solids, total suspended solids, and the concentrations of oil and grease in similar holding ponds located in the eight-state area will be discussed. For each chemical species identified, the types of reactions and fates of each species in the pond will be discussed based on current literature.

6. A Comparison of Water Consumption Numbers

The water consumption numbers used in the study are generally lower than those cited in Federal Power Commission (FPC) dockets, environmental impact statements, and much of the open literature. The numbers being used in the study are a product of the water minimization work performed by WPA during the first phase of the project.[1] WPA's numbers will be compared with numbers from the Lurgi process FPC docket and environmental impact statements submitted by El Paso Natural Gas, WESCO, and Michigan Wisconsin-American Natural Gas. Specific itemized water consumption differences will be identified and explained.

7. Tradeoffs for Selected Water Use Mixes

Several mixes of agricultural, industrial, energy, and other uses will be selected on the basis of mixes projected by studies conducted for the National Commission on Water Quality,[2] the Northern Great Plains Resources Program,[3] and other major studies. Each of these water use mixes will be analyzed to determine the impact tradeoffs that can be anticipated for various levels of energy, agricultural, and industrial development.

8. New Technologies

Radian will summarize water requirements of each of the new technologies and associated population increases using the ERDS data base. A source of water to meet these needs will be identified, and the impacts of these withdrawals (including stream low flows and ground-water levels) will be identified.

The effluents, emissions, and other potential sources of ground- and surface-water contamination (such as runoff sources and mine discharges) will also be identified for each technology.

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[1]Gold, Harris, et al. Water Requirements for Steam-Electric Power Generation and Synthetic Fuel Plants in the Western United States. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-037)

[2]Utah State University, Utah Water Research Laboratory. Water Pollution Control Act of 1972; Regional Impacts: Colorado River Basin. Washington, D.C.: National Commission on Water Quality, 1975. (NTIS Order #PB-249 600)

[3]Northern Great Plains Resources Program; Report of the Work Group on Water. Billings, MT: U.S. Department of the Interior, Bureau of Reclamation, 1974.

Potential impacts (including their likelihood and their significance) of the contaminant sources on local surface- and ground-water systems will be identified. The results of the effluent pond seepage analyses described above will be incorporated. All analyses will be time-phased up to and beyond the year 2000, as appropriate.

The extensions and refinements to the water impact analyses described above are intended to provide a more adequate basis for making better informed western energy resource development policies. Specifically, the results of these extended and refined analyses are intended to:

- o Identify and evaluate potential water savings by minimizing both energy and non-energy water consumption.
- o Identify and evaluate the potential for avoiding or mitigating water impacts by prohibiting the siting of some technologies at some locations.
- o Estimate the economic cost of regulations which would require energy developers to minimize water consumption.
- o Identify and evaluate the potential impacts of on-site ponding of water effluents and determine how these impacts might be avoided or mitigated.
- o Identify and evaluate the tradeoffs of various energy and non-energy water use mixes.

C. Social/Economic/Political

During the first year, the emphasis in social/economic/political impact analysis was on direct and selected indirect population related impacts, particularly on the availability of basic services and facilities such as housing and schools and revenues to meet increased capital and operating costs. Since no major changes are required, the emphasis will be on an analysis of the impact of the technological alternatives that are being added to the site-specific and eight-state scenarios. Several impacts will also be examined in more detail. These are:

1. Post-Operation Phase

The bust phase (post-operation) of energy facilities will also be analyzed more fully. Some facilities are more likely than others to be phased out after a 10 to 30 year period. For example, export coal mines, uranium mines, and oil and gas production are likely to be shut down, whereas power plants and conversion facilities would probably be maintained, perhaps by transporting coal or other fuel to the facilities.

2. Local Labor Force

Variations in local labor forces and current employment potenial of residents in the West will be examined in more detail. This will be coupled with information on the likely sources of immigrants to the West. The distribution of oldtimers and newcomers will affect the benefits received by current residents, in terms of employment, income gains, etc. Where possible, inflation and its distribution among groups will be more carefully assessed.

3. Inter-Industry Linkages

Competition in the local labor market is one of many forces affecting non-energy industries, particularly agriculture. Water, too, will be a point of competition between industries at many locations. On the other hand, energy development may attract new businesses in hitherto isolated locations, e.g., wholesaling, light manufacturing, processing of byproducts. Inter-industry linkages, both positive and negative, will be given more attention in the extension and refinement of these analyses.

4. Public Finance

An accurate assessment of public finance impacts is not possible given the limitations of site-specific data on such matters as jurisdictional boundaries, assessment practices and formulas, and land ownership. However, efforts will be made to augment the data base so that potential revenue shortfalls and surpluses can be pinpointed more precisely. Also, as part of the fiscal impact analysis, a greater variety of energy development schedules will be examined to see how well "lead-time" problems might be mitigated by rescheduling.

D. Ecological

The results of ecological impact analysis during the first year indicate generally that: (1) many impacts to plants and animals are likely to result from energy development, primarily as a consequence of increases in human populations in development areas; and (2) local impacts can vary greatly depending upon the technology and where it is deployed (that is, technological and locational factors determine impacts). No major extensions or refinements are contemplated. However, the results of the revised air, water, and social/economic/political analyses will be introduced into the ecological impact analysis. If feasible, ambient concentrations of toxic elements from power plants will be considered. Instream flow effects on plant and animal communities will also be examined in more detail utilizing data from studies being supported by the Office of Biological Services of the Fish and Wildlife Service. And the results of reclamation studies by the Forest Service in the Surface Environment and Mining (SEAM) program will be used to refine our reclamation discussion.

E. Health Effects

During the first year, the analysis of health effects consisted of a review of the literature on disease-producing residuals and the identification of health problems. The review included carcinogenic polynuclear aromatic hydrocarbons, toxic trace elements, mine accidents and exposure to radiation.

In addition to extending and refining this initial review, an attempt will be made to identify and, to the extent possible, quantify increased health hazards to human populations. This extended analysis will focus on several major categories of potentially harmful residuals and accidents and relate them to workforce personnel and the general public. Workforce and population projections of increased mortality and decreased life expectancy will be based on doses for selected pollutants. Dose-response relationships will be derived from data compiled at Brookhaven and Argonne National Laboratories.[1]

Comparing epidemiological data from diverse geographic settings or from facilities with different process designs will likely result in estimates with wide ranges of error. However, by including ranges of values and clearly stating assumptions, an estimate of the relative magnitude of health risks can be made and major sources of variation identified.

F. Transportation

In the first year, cost comparisons of alternative modes of transportation were initiated and preliminary results reported. Materials and equipment needs were identified and quantified. Extension and refinements planned for transportation include:

- Identifying levels of development that could saturate existing transportation capabilities;
- Extending the analysis and comparison of alternative transportation modes;
- Focusing more attention on the location of resources in relation to existing transportation facilities; and
- Attempting to provide better answers to such questions as the availability of materials and equipment; for example, are there enough hopper cars and, if not, can enough be produced?

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[1]Argonne National Laboratory, Special Task Group. Preliminary Assessment of the Health and Environmental Impacts of Fluidized-Bed Combustion of Coal as Applied to Electrical Utility Systems. Argonne, IL: Argonne National Laboratory, 1977. The Brookhaven data are included in the Argonne report.

G. Noise

Except for considering the technologies that are to be added, noise impact analyses will not be extended and refined. However, noise will be dealt with more extensively in both the transportation and aesthetics analyses.

H. Aesthetics

Aesthetics received limited attention during the first year, largely because aesthetic impacts are difficult to deal with and because of the level of effort required in the four basic impact categories (air; water; social/economic/political; and ecological). In completing the impact analysis, aesthetics will be dealt with directly by identifying the kinds of tangible impacts that will occur. For example, the introduction of stacks, large facilities, noise, odors, and reduction of visibility. To the extent they are dealt with, subjective aesthetic impacts will be included in the analysis of lifestyle and quality-of-life impacts in the social, economic, and political impact analyses.

2.4 INTERACTIVE EFFECTS

In the final stages of completing Energy From the West, the team began to detect interactive effects that were initially overlooked because of the emphasis being given to the categorization of impacts. For example, there are numerous interactive effects among air and water quality, health effects, and social/economic/political impacts. (Flue gas desulfurization creates a solid waste disposal problem; and air pollutants can be related to human health and human health to the availability and delivery of health care, etc.)

The interdisciplinary team approach, particularly the internal review sessions, will be used to structure a more systematic identification of interactive effects. We also believe that questions arising in the conduct of policy analyses and in the review of policy analysis papers can be expected to focus attention on interactive effects and identify a need for additional impact analyses.

2.5 UNCERTAINTY

In the results of the extended and refined impact analysis, we will attempt to provide a better assessment of the remaining uncertainties. For example, data quality and the analytical tools employed will be assessed, and, where possible, the level of confidence that should be accorded results will be indicated. The risk associated with failures such as accidental discharges from holding ponds will also be discussed, the probability of an impact occurring will be assessed, and risks and probabilities of a failure occurring will be categorized.

2.6 REPORTING THE RESULTS OF IMPACT ANALYSES

When the changes described above are completed, a final impact analysis report will be prepared and distributed for comments and suggestions. The emphasis in this report will be on the identification of critical technological and locational factors, the identification and characterization of risks, and the identification of the probability of various impacts actually occurring. The report, which will be issued in the spring of 1978, is one of the background and supporting material reports described in Chapter 4.

CHAPTER 3

POLICY ANALYSIS

3.1 INTRODUCTION

Technology assessments (TA) are a kind of applied policy analysis study undertaken to: (1) inform public and private policymakers and interested citizens about the likely consequences of a decision to develop and deploy a technology; and (2) identify, evaluate, and compare alternative policies and implementation strategies for dealing with problems and issues that either are perceived or are actually likely to arise when a technology is deployed. To achieve the first objective, three questions must be answered: (1) are the consequences that have been anticipated actually likely to occur; (2) are there also likely to be consequences that have not been anticipated; and (3) if either or both kinds of consequences occur, how serious will they be? To achieve the second objective of a TA, the answers to these three questions must be related to the social and political context within which the technology will be developed and deployed. The questions to be answered in this case are: (1) what alternative policies and implementation strategies can reasonably be used to maximize benefits and minimize costs and risks when the technology is developed and deployed; and (2) how will these alternatives distribute costs, risks, and benefits throughout society?

In this Chapter, we briefly describe our interpretation of TA as applied policy analysis, identify and describe the kinds of analyses that must be completed to achieve the two TA objectives identified above, and describe the analyses being conducted in our TA of western energy resource development.[1]

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[1]See White, Irvin L., et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976 (EPA-600/5-76-001, NTIS Order #PB-252 034/AS) for a description of the Science and Public Policy Program's (S&PP) interdisciplinary team approach to technology assessment.

3.2 TECHNOLOGY ASSESSMENT AS APPLIED POLICY ANALYSIS

Applied policy studies, including TA's, generally involve two kinds of analyses: technical and policy.[1] Technical analyses evaluate and compare technologies on the basis of objective and, to the extent possible, unbiased, scientific and technical criteria;[2] policy analyses interpret the results of the technical analyses in the context of the social/political system within which the technology is developed and deployed.

3.2.1 Technical Analysis

As explained in the conceptual framework for technology assessment described in our First Year Work Plan, impacts occur when the inputs and outputs of a technology interact with the conditions existing at the location where the technology is deployed (see Figure 3-1). Therefore, the evaluation and comparison of technologies begins with a description and comparison of inputs, outputs, and existing conditions. Technologies can be evaluated and compared in terms of inputs such as capital, labor, and land requirements and outputs such as the quantities of electricity and sulfur dioxide produced. Existing conditions can be evaluated and compared on the basis of such factors as the availability of public services, sectors of economic activity, attitudes toward energy development, air dispersion potential, and water availability and quality.

A variety of technical analyses such as those described in the preceding chapter, our First Year Work Plan, and Energy From the West,[3] can be used to determine what the likely impacts of developing and deploying a technology will be. Impacts can be compared on the basis of such things as changes in the ambient air concentration of sulfur dioxide, per unit energy costs, and demand for public services such as water and sewage treatment. Impacts

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[1]These two terms are not altogether satisfactory since both kinds of analysis are integral parts of policy analysis. The analyses described under the policy label in this section are those which emphasize the political aspects of the overall applied policy analysis.

[2]Although the technical analyses performed to date in this study have focused almost exclusively on impacts, technical analysis need not be limited to impact analysis. As used here the term technical analysis generally includes a wide range of engineering studies and quantitive and qualitative analyses.

[3]White, Irvin L., et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols. and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d)

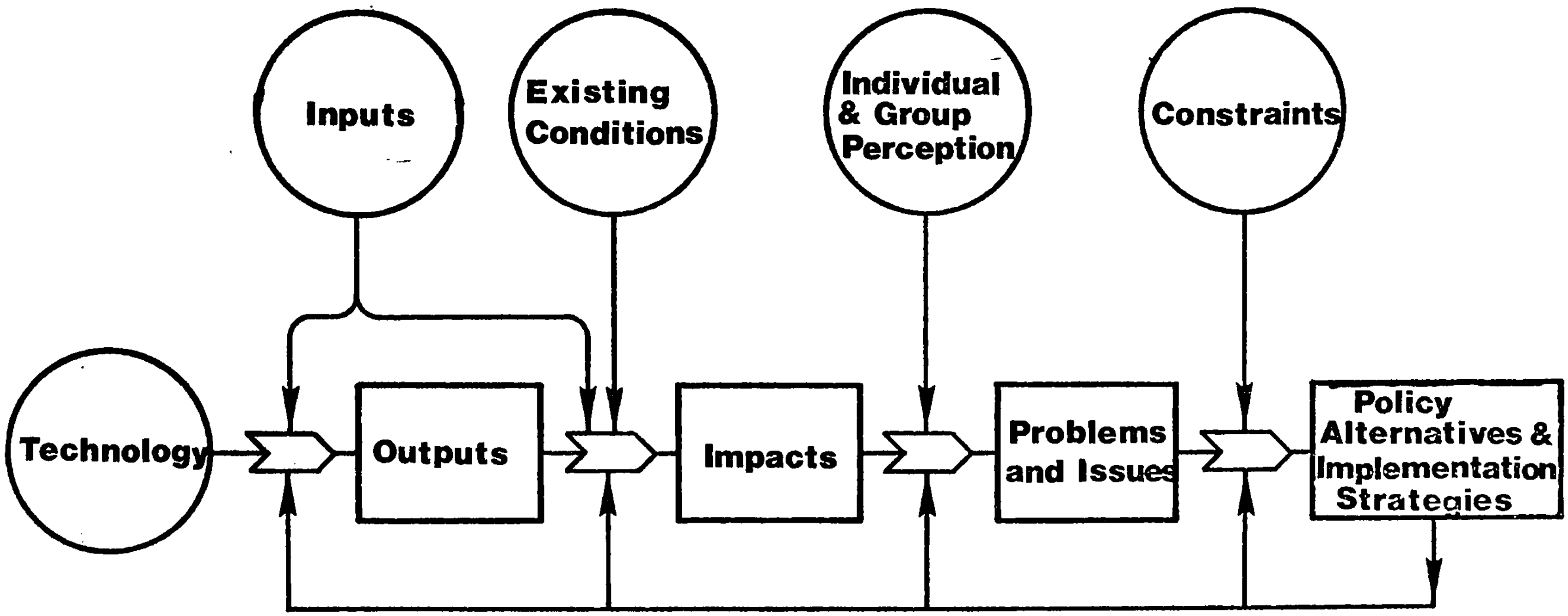

FIGURE 3-1: A CONCEPTUAL FRAMEWORK

can also be compared in terms of their probability of occurrence, magnitude, duration, and seriousness.

In short, descriptions of the technologies and locations together with the results of the analyses of the impacts likely to occur when they are interacted can be used to inform policymakers about the costs, risks, and benefits of various technology and siting options. However, the results of the technical analyses will always be incomplete, largely because of the limited explanatory power of existing theories and either the inadequacy or unavailability of data and analytical tools. Even if it were possible to overcome these limitations, the results of the technical analyses would not be an adequate basis for policymaking. Policymakers need to know more than the costs, risks, and benefits of technological and siting alternatives evaluated and compared on the basis of objective criteria. They need to know how costs, risks, and benefits will be distributed, which interests and values will be promoted at the expense of which others, how to promote the interests and values they wish to promote, and how to avoid unwanted costs and risks. The policy analyses described below are intended to produce results responsive to these needs.

3.2.2 Policy Analysis

A. The Three Steps in Policy Analysis

The policy analyses in a TA are conducted in three steps:

- o The identification and definition of problems and issues;
- o The description of the social and political context of issues associated with the development and deployment of the technology; and
- o The identification, evaluation, and comparison of alternative policies and implementation strategies.

1. <u>The Identification and Definition of Problems and Issues.</u>[1] Some problems and issues associated with the development and deployment of a technology will be identified when the conditions existing at the time and location of deployment are described.

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[1]The terms problems and issues are not synonyms. Problems such as those resulting because of the labor and capital intensity of a technology may or may not lead to an issue being raised. The key distinction is that issues involve conflict among competing interests and values. Not all problems produce conflicts, consequently both terms must often be used. This frequently is awkward and in this chapter only one or the other term will ordinarily be used, "problem" when conflict is not involved or is not being emphasized, "issue" when it is.

That is, some problems and issues are anticipated independently of the technical analyses described in Section 3.2.1, perhaps on the basis of analysis, but often on the basis of past experience, analogy, and speculation. But some problems and issues may not be anticipated; consequently, as shown in Figure 3-2, a beginning step in policy analysis is for the interdisciplinary research team systematically to review the results of the technical analyses to prevent otherwise unanticipated consequences from being overlooked. Others may be added as a result of the policy analyses themselves.

IDENTIFY AND DEFINE PROBLEMS AND ISSUES

- o Define problems and issues already identified by participants in the system;
- o Define problems and issues identified by the interdisciplinary research team in its review of impact analysis results;
- o Define problems and issues identified by the interdisciplinary research team in the conduct of the policy analysis.

FIGURE 3-2: POLICY ANALYSIS: STEP 1

2. The Description of the Development and Deployment Context. In the second policy analysis step, both anticipated and unanticipated problems and issues are related to the social and political context within which the development and deployment of the technology will take place. This requires that the relevant policy system or systems be identified and described in substantive terms. This "issue systems" approach is based on the observation that political systems vary according to the substance of the issue being processed.[1] The interests and values at stake, relevant institutional arrangements, applicable laws and regulations, governmental and nongovernmental participants, and intensity of involvement of various participants can vary on the basis of substance. For example, the substance of health care problems leads to the definition of a different issue system than does national security; and the substance of nuclear energy problems leads to a different issue system definition than would oil and gas.

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[1]An issue system may be defined in terms of a single issue such as what the ambient concentration standard for sulfur dioxide should be or on a category of problems and issues such as air quality.

For issues that the political system has dealt with in the past, the identification of the issue system begins with an examination of key elements in the historical development of the issue: when did the issue arise; which participants in the system perceived that it was an issue and what interests and values did they represent; when did government respond; how did government respond and what policies were enacted; who administers these policies; and how have these policies affected the issue? This step also includes a more detailed identification and description of the existing system for dealing with the issue: what are the relevant current public and private, formal and informal institutional arrangements; what interests and values are at stake, who represents them and what strategies and tactics are they employing; and are there situational or social and physical environmental conditions and circumstances that either affect or could potentially affect whether and how the issue is processed?[1]

The procedural steps for describing the development and deployment context are outlined in Figure 3-3.

3. The Identification, Definition, Evaluation, and Comparison of Alternative Policies and Implementation Strategies. In the policy analysis step of a TA, policy alternatives and implementation strategies are identified, defined, evaluated, and compared. Alternatives and implementation strategies for dealing with issues already being processed by the system will have been identified in step 2 above. However, the interdisciplinary research team also formulates alternatives itself, both for issues already being processed and for problems and issues likely to arise as a consequence of unanticipated impacts identified when the technical analyses were reviewed. Drawing from both sources, the team reduces the number of alternatives and strategies to be evaluated and compared in detail to a manageable number.[2] As described in our

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[1]Not all of the items listed here apply to all problems and issues. Which of them apply is determined by the stage of development of the problem or issue. Some will be "well developed," and all of the listed items will be applicable; others will be just emerging or not yet anticipated independently of the TA and few if any of the listed items will be applicable.

[2]As the description of our interdisciplinary team approach indicates, the selection from among all possible alternatives (or all that team members can identify) is arbitrary. There are two major checks on this: first, the interdisciplinary team reviews inputs from individual team members; and second, the team's products are subjected to extensive external reviews. Both internal and external review help to minimize bias, factual and interpretative errors, and errors by oversight. See our First Year Work Plan, and White, Irvin L. "Interdisciplinarity," pp. 87-96 in Arnstein, Sherry R., and Alexander N. Christakis, eds. Perspectives On Technology Assessment. Jerusalem, Israel: Science and Technology Publishers, 1975, for a description of these procedures.

DESCRIBE THE DEVELOPMENT AND DEPLOYMENT CONTEXT

o Describe the key elements in the historical development of the issue:

- When did the issue arise?

- Which participants in the system perceived it as an issue?

- What interests and values did these participants represent?

- When and how did government respond?

- What policies were enacted or established?

- What agency administered these policies?

- How have these policies affected the issue?

o Describe the existing system for dealing with the issue:

- What are the relevant, current public and private, formal and informal institutional arrangements?

- What interests and values are at stake?

- Who represents these interests and values and what strategies and tactics are they using?

- Are there situations or social and physical environmental conditions and circumstances that either affect or could affect whether and how the issue is processed by the system?

FIGURE 3-3: POLICY ANALYSIS: STEP 2

First Year Work Plan, this is accomplished by applying a number of filters to isolate those alternatives and strategies that appear to be most significant and feasible. Since alternatives distribute costs, risks, and benefits differently, the filtering of alternatives requires at least a preliminary assessment of what the distributive effects of each alternative would be. For example: (1) which individuals, groups, or organizations would benefit more than or at the expense of others; (2) which costs, risks, benefits would be transferred from some individuals, groups, or organizations to others; and (3) would existing regulations have to be modified, eliminated, or new regulations have to be added to existing programs, or would new regulatory programs have to be established? A detailed evaluation and comparison of all possible alternatives is not feasible and is limited to the few alternatives which survive the internal and external review processes mentioned earlier. (See Figure 3-4)

Implementation strategies can also affect the distribution of costs, risks, and benefits. However, the first evaluation and comparison of implementation strategies is in terms of the relative ease or difficulty of implementing an alternative. That is, implementation is one of the several constraints or barriers used as a filter in determining the feasibility of an alternative.[1] But the analysis of implementation strategies also includes identifying means for gaining acceptance of an alternative and achieving its objectives.

Another key consideration in the evaluation and comparison of alternatives is utilization. An essential component of the interdisciplinary team approach described in our First Year Work Plan and in Energy From the West is the participation of the potential users of the team's research products including representatives of the broad range of interests and values that are at stake. As noted above, this "participatory research" approach includes involving users in the filtering of alternatives and implementation strategies.[2]

4. Criteria for Evaluating and Comparing Alternatives. While the results of the policy analyses described above will seldom if ever eliminate the uncertainties that public and private policymakers face in making decisions to develop and deploy technologies, these results can help them to make better informed choices than they would otherwise be able to make. Results of policy analyses are useful in this regard to the extent that they systematically describe, evaluate, and compare using clearly specified criteria and appropriate qualitative and quantitative measures, indicate theoretical, data, and analytical tool limitations, and specify confidence levels.

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[1]See our First Year Work Plan.

[2]Utilization is discussed more generally in Chapter 5 of this work plan.

IDENTIFY, EVALUATE, AND COMPARE
ALTERNATIVE POLICIES
AND IMPLEMENTING STRATEGIES

- o Identify and describe alternative policies and implementing strategies already being proposed for dealing with existing problems and issues;

- o Describe alternative policies and implementing strategies formulated by the interdisciplinary research team;

- o Reduce the number of alternative policies and implementing strategies to a manageable number by identifying those which are most significant and feasible.

  - -Filter the complete list of alternative policies and implementing strategies by conducting a preliminary evaluation of how they distribute costs, risks, and benefits;

  - -Identify the barriers or constraints (e.g. legal, ethical, moral, difficulty of implementation, economic, etc.) to acceptance and implementation;

  - -Submit the team's reduced list of alternatives and strategies to external review.

- o Describe the costs, risks, and benefits of each alternative and implementation strategy:

  - -Which individuals, groups, or organizations would benefit more than or at the expense of others?

  - -Would existing regulations have to be modified, eliminated, or new regulations added to existing programs or would a new program have to be established?

- o Compare alternatives and strategies on the basis of explicit criteria using a variety of measures.

FIGURE 3-4: POLICY ANALYSIS: STEP 3

Despite many policymakers' desire to have a "bottom line," no single measure or evaluation criterion can provide an adequate summary of the costs, risks, and benefits of alternative policies and implementation strategies. We have discussed the use of multiple measures and evaluation criteria in Chapter 5 of our First Year Work Plan. As described there, the combination of measures and criteria to be used is determined both by what is being evaluated and the interests and values that are at stake. Although the measures and criteria that are used most frequently are economic, these are not always applicable and do not always provide an adequate basis for evaluation. For example, dollars are not an adequate measure of aesthetic values nor do they always provide the best indication of how equitably an alternative may distribute costs, risks, and benefits. And while it is possible to determine the dollar cost of environmental controls, the associated social costs often cannot be determined. By themselves, economic measures and criteria can be used to evaluate only one component of overall costs, risks, and benefits. Consequently, in the policy analyses discussed in Section 3.3, a combination of measures and evaluation criteria appropriate to the issue being considered will be used, including, when appropriate, those described in Chapter 5 of our First Year Work Plan.

B. Integrating the Results of Policy Analyses

The initial product of the policy analyses described above is a series of papers focusing either on specific issues or categories of issues. To achieve the objectives of the TA, these must be integrated on the basis of cross-cutting problem or issue categories such as inter- and intra-governmental relations, the adequacy or inadequacy of existing formal and informal mechanisms for conflict resolution, and the adequacy or inadequacy of the structure of existing agency programs. A major integrating task is to identify what these cross-cutting categories should be.

3.2.3 Overlap and Interaction of Technical and Policy Analyses

Although the above abbreviated description of technical and policy analyses may make it appear that they are performed in sequence, they actually overlap and there are numerous interactions between the two. In fact, the two are mutually informing. For example, initial decisions concerning what technical analyses to undertake are informed by a preliminary policy analysis which identifies the problems and issues that policymakers are likely to have to deal with; and the later, more detailed policy analyses will almost certainly raise questions that will necessitate additional technical analyses. Over the duration of a TA emphasis shifts from technical to policy analyses. But technical analyses uninformed by the results of policy analysis are likely to be wasteful and inadequate to inform the final policy analyses; and policy analyses uninformed by the results of technical analysis do not provide a basis for well-informed policymaking.

Properly performed, the technology assessment process is iterative: the initial technical analyses are informed by preliminary policy analyses; the results of the technical analyses help to define the scope and focus of policy analyses; the policy analysis identifies additional technical analysis needs; and so on. There is constant interaction between the two kinds of analysis as the interdisciplinary team learns during the course of a project.

3.3 POLICY ANALYSIS IN THE WESTERN ENERGY STUDY

3.3.1 Introduction

The results of analyses completed during the first phase of this TA are reported in Energy From the West. Technical analyses such as those described in Section 3.2 above were emphasized during this phase, and, as explained in Chapter 2 above, these analyses are being extended and refined to inform the policy analyses currently in progress.

Policy analysis during the first phase was limited to the preliminary identification and definition of several major problem and issue categories. In completing the TA, policy analyses (as distinct from technical analysis) will be performed in the three steps described above:

- o The identification and definition of problems and issues;
- o The description of the social and political context of issues associated with the development and deployment of the technology; and
- o The identification, evaluation, and comparison of alternative policies and implementation strategies.

3.3.2 The Identification and Definition of Problems and Issues in Western Energy Resource Development

Since this TA got underway in July, 1975, members of the S&PP interdisciplinary research team have been identifying the problems and issues actually being raised concerning the development of western energy resources. A preliminary analysis of these problems and issues (see Section 3.2.3) helped to inform the team's initial decisions concerning what technical analyses to undertake; and the preliminary policy analyses reported in Energy From the West focused largely on the identification and definition of these problems and issues.

The team reviewed the results of the impact analyses completed during phase one to determine two things: first, whether the problems and issues already being raised are actually likely to occur (e.g., water shortages); and, second, whether there are problems and issues not being discussed which are likely to arise as a consequence of the unanticipated impacts the team has identified (e.g., the possible contamination of ground and surface water from onsite evaporative holding ponds). Both determinations were based for the most part on impact analysis results that identified critical technological and locational factors which can cause impacts to vary significantly.[1]

As a consequence of this review of impact analysis findings, the team identified seven categories of problems and issues that warrant priority treatment in the second phase of the TA.[2] These are:

- o Water Availability and Quality;
- o Air Quality;
- o Planning and Growth Management;
- o Land Use and Reclamation;
- o Capital Needs;
- o Facility Siting; and
- o Transportation.

The following are among the considerations which led the team to select these seven categories:

1. Water

- o Water is a scarce resource in much of the eight-state study area and using water for energy development will create or exacerbate conflict among water users. Technological alternatives available to both energy and non-energy users could lessen their water requirements. For example, requiring wet/dry rather than wet cooling can reduce water consumption by as much as 50 percent for

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[1]These two factors were not, of course, the only considerations taken into account. For example, scale and rate are important considerations which affect the impact of both technological and locational factors. And considerations such as duration, reversibility, and the size of the area and/or populations affected were taken into account. See Chapter 5 of the <u>First Year Work Plan</u>.

[2]Subsequent discussions with legislators, mayors, state and federal agency personnel, and numerous interested individuals have confirmed that these categories are appropriate to structure our policy analyses.

most energy conversion technologies; process design changes could reduce water consumption even further; and water consumption for agricultural purposes could be reduced by the use of water-saving irrigation technologies, selection of less water-intensive crops, and elimination of water-intensive plants along streams and irrigation ditches.

- Estimates of water availability for future development vary considerably, particularly for the Colorado River. Projected energy and non-energy water consumption exceeds several of these water availability estimates.

- Current development practices include the discharge of water effluents by energy conversion facilities into on-site evaporative holding ponds. Large quantities of these effluents will accumulate over the lifetime of a facility, including toxic materials. The accidental discharge of these effluents, seepage into ground and surface water, and their ultimate disposal when the facility is shut down pose potentially significant impact problems and may warrant control, including the regulation of pond design, maintenance, and shut-down.

- Population increases in small towns and rural areas will often, at least in the short term, result in increased use of septic tanks, sewage lagoons, and the discharge of untreated or inadequately treated wastes. Existing waste treatment assistance programs are not (and are not presently designed to be) responsive to the specific needs of energy-impacted communities.

2. Air

- Most of the energy developed in the eight-state study area will be exported to adjacent states or to other regions of the country. Development will adversely affect air quality in the West where the existing air quality is generally much better than what is required by EPA ambient air quality standards.

- Exporting coal would lessen both air quality impacts and economic benefits and economic growth possibilities in the West.

- Exporting coal would export most of the air quality impacts (and possibly health effects) to other states or regions.

- In some areas of the West, background ambient concentrations of hydrocarbons and particulates from natural sources are high and given existing national air quality standards, development in these areas may be either limited or precluded.[1]

- o EPA's current emissions "offset" policy permits new facilities to be sited (and, therefore continued economic growth) in non-attainment areas where concentrations of criteria pollutants exceed air quality standards; however, in the West, Prevention of Significant Deterioration policies can effectively prohibit development in certain areas where existing air quality is much better than current ambient air quality standards require.

3. Planning and Growth Management

- o Most of the development of energy resources in the western U.S. will take place near small towns or in rural areas. Large energy-related population increases will exceed the capability of small towns and counties to provide the necessary services and facilities. At best, most of these towns and counties have only a limited planning capability. And they often do not possess or receive adequate planning information far enough in advance to plan effectively even if they have a professional planning capability.

- o Existing revenues for most towns are inadequate to provide the facilities and services needed during the initial phases of development. This is in part because increases in revenues from energy development generally accrue to county and state governments rather than to the towns which must provide most of the services and facilities for energy-related population increases.

- o Adequate housing, particularly during the early phases of development, is almost always in short supply. Both public and private sector responses have tended to be inadequate. Prices escalate and mobile homes proliferate, often in uncontrolled areas outside of towns.

4. Land Use and Reclamation

- o Energy development can affect large amounts of land both directly (e.g., mines, conversion facilities, and access roads) and indirectly (housing and recreation).

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[1]The high ambient concentrations of particulates usually result from blowing dust, a natural phenomenon. But the root cause may be bad management practices which have made the soil susceptible to being blown by the wind.

- o Mineral resource development on federal lands, including energy resources, is governed by rules and regulations that limit federal control over development activities as well as federal revenues. The overall system of state and federal regulation of resource development provides for only limited federal-state cooperation and coordination.

- o If not adequately controlled, energy-related land disturbances in particularly vulnerable areas such as alluvial valleys will cause serious impacts.

- o Although current regulations require that all surface-mined lands be reclaimed, reclamation will be difficult and expensive in some areas of the West, particularly in the arid Southwest.

- o Unless access to recreational areas in the vicinity of energy development is controlled and recreational activities such as off-road vehicles and hunting regulated, these areas will be damaged, including the fragmentation of habitat, destruction of biota, and possible destruction of archaeological sites.

- o Currently available recreational areas will be inadequate to meet the recreational needs of the present population, energy-related population increases, and tourists.

5. Capital Needs

- o Capital needs for western energy resource development can require an investment on the order of $200 billion (constant 1975 dollars). It is not clear that investors will be willing to make an investment of this magnitude to develop these resources.

- o Investment decisions will be affected by pricing policies, the economic costs of environmental protection, bureaucratic processes and procedures, inter-regional rivalries, competition in energy markets, and opportunities to share financial risks.

6. Facility Siting

- o Siting is still largely controlled by state and local governments but national policies greatly affect the kind and location of facilities and how they will be operated. Current siting policies and procedures in most states are inadequate to meet the challenge of greatly increased domestic energy production to lessen dependence on external sources. Developers (and their opponents) are frequently frustrated by a system of siting laws and regulations that is fragmented, slow, and unpredictable.

- Siting marries a technology and a site and, thereby, largely determines what impacts will occur and who will bear them. Opposition to siting a facility is often based on a concern for a particular impact, such as air quality. Since different participants in the policy system use different criteria to evaluate a site, it is difficult to avoid siting conflicts.

- Regulations such as Prevention of Significant Deterioration may constrain development by either significantly reducing the number of available sites or by making it impossible to site certain kinds of technologies at certain locations.

7. Transportation

- Much of the energy produced in the West will be exported to other states in the region or to demand centers outside the region. Each of the transportation modes that will be used will produce a different set of impacts. For example, slurry pipelines will export water from a water scarce region and unit trains can create substantial traffic problems for small towns unless overpasses are constructed.[1]

- Current federal and state policies give an advantage to some modes of transportation over others. For example, only a few states grant an eminent domain right to slurry pipelines equivalent to what they grant to railroads.

- Existing transportation capabilities in the West are generally inadequate to meet the transportation requirements of large-scale energy development. Meeting these needs can require an investment of more than $40 million (constant 1975 dollars) by 2000. This would be almost 30 percent of the regional investment in extraction and conversion facilities.

- The interstate transport of energy may lead to conflict among states, between regions, and between states, regions, and the federal government. If the choice of

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[1]Electricity and synfuels also export water since water is consumed in converting a raw resource into these fuels. However, water exports are more likely to be a perceived problem in the case of slurry pipeline

transportation alternative and routing is made by the federal government, regional, state, and local interests may be down-played; on the other hand, if state and local governments make these choices, power pooling, transportation corridors, and certain modes of transportation may be ruled out.

Obviously these seven categories are not mutually exclusive. Problems and issues have been categorized this way to emphasize some of the major problems and interest and value conflicts that policymakers will have to deal with in making western energy resource development policies. As indicated above, the S&PP interdisciplinary research team selected these seven categories to initiate the indepth policy analyses that are now the team's major research activity. These categories will be redefined and modified as appropriate as the indepth policy analyses progress. While the selection and categorization is somewhat arbitrary, the extensive external review process briefly described in Section 3.2 will provide a check on the team's selection and will contribute to any redefinition, adding of issues, or other modifications that the team may decide to make.

3.3.3 The Description and Political Context of Issues Associated With the Development of Western Energy Resources

A policy analysis of each of the seven categories of problems and issues discussed in Section 3.2.2 has begun. The relevant policy system or systems are being identified and described using the issue systems approach and analytical procedures outlined in Section 3.2.2 above. As called for by those procedures, the key elements of the historical development of the problem and issue category are being examined and integrated into an overview description of the existing issue system. To promote and facilitate comprehensiveness and comparability, a general checklist of interests and values is being developed and used to take an interest and value conflict inventory as a part of each of the seven separate policy analyses. An overall energy policy system description is also being prepared, building on the description included in Energy From the West,[1] but focusing more specifically on major economic growth/energy/environment conflicts and changes in public/private sector and intergovernmental relationships that have been and are occurring since energy policy became a major public policy concern.

A description of the different patterns that western energy resource development can take, the differences in impacts that

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[1]Chapter 13. The description in Energy From the West was adapted from Kash, Don E., et al. Our Energy Future: The Role of Research, Development, and Demonstration in Reaching a National Consensus on Energy Supply. Norman, OK: University of Oklahoma Press, 1976.

these patterns will produce, and how national and state policies will influence development is also being prepared to set the context of the seven separate analyses.

Together, the descriptions of the energy policy system and energy development patterns provide an overview context within which to analyze each of the seven separate categories of problems and issues and an integrating overview of how these separate analyses relate to each other, where problems and issues have been omitted that should be included, and the relative importance of the range of problems and issues that policymakers are and will have to deal with in connection with western energy resource development.

3.3.4 The Identification, Definition, Evaluation, and Comparison of Alternative Policies and Implementation Strategies

As described in the policy analysis procedures outlined above, the third step in policy analysis is to identify, define, evaluate, and compare alternative policies and implementation strategies. This part of the policy analysis of the seven problem and issue categories identified above is now underway. Alternatives and strategies being considered include those being proposed by participants in the policy system, identified by the interdisciplinary team, and suggested by outside reviewers. The individual team member initially responsible for the analysis of a category of problems and issues selects from among all the alternatives and strategies that have been identified those which seem to warrant detailed analysis. As successive drafts of the analysis are reviewed internally (and less often externally), the choice of which alternatives and strategies warrant in-depth treatment ceases to be an individual decision.

To assist team members in carrying out what are initially individual assignments and to insure comprehensiveness and comparability, alternatives and strategies are being categorized and an overall checklist of evaluation criteria is being prepared. Whether an alternative would avoid or mitigate, be a short- or long-term response, involve a technological fix or require a change in behavior, be affected significantly by state-of-society changes, be significantly affected by changes in national policy, or produce an irreversible change are among the considerations being taken into account in categorizing alternatives. Considerations in categorizing implementation strategies include whether legislative action would be required, whether a new agency would have to be established, and whether more than one agency or level of government would be involved. The check list for use in evaluating and comparing alternatives will include at least four categories of evaluation criteria: effectiveness (achieving the policy objective), efficiency (the associated costs), equity (the distribution of the associated costs, risks, and benefits), and flexibility (accommodation of differences, e.g., among regions).

As noted above, which criteria (and measures) are applicable and appropriate varies among substantive problem and issue categories. The overall checklist of evaluation criteria serves only as a starting point and each policy analysis will explicitly identify the criteria (and measures) being used in the evaluation and comparison of alternatives.

3.3.5 The Policy Analysis Report

The team can expect to find a number of recurrent themes emerging from the individual policy analysis papers. For example, changes and the effects of intergovernmental and private-public sector relationships are pervasive, and what is learned about them in the separate analyses will need to be integrated. This integration will be accomplished in the Policy Analysis Report described in the next chapter.

CHAPTER 4

REPORTS

4.1 INTRODUCTION

In addition to a final, integrating technology assessment (TA) report, this project will produce a number of background and supporting materials reports. Each of these reports will be briefly identified and described in the following section. A timetable for completing the project is also included.

4.2 BACKGROUND AND SUPPORTING MATERIALS REPORTS

4.2.1 Energy Resource Development Systems

The energy resource development systems (ERDS) descriptions, now being reviewed externally and revised for publication, consist of two parts. Part I describes the laws and regulations of the federal government and the eight states within the study area which control or regulate the deployment and/or operation of energy resource development technologies for more than one resource. For example, most of the laws and regulations for air and water quality are not resource specific. Part II consists of a separate chapter for each of the six resources. Each chapter describes the resource base, technological alternatives, input requirements, product and residual outputs, economic costs, energy efficiencies, and resource specific laws and regulations.

Information and data presented in these ERDS are a codification of the baseline required by the team to perform impact and policy analyses. They provide readers an opportunity to examine the team's data base in detail; and users of our final TA report will find the ERDS useful as a compendium of information and data about western energy resource development.

4.2.2 Impact Analysis Report

A final impact analysis report will be prepared as a major component of the background and supporting materials to be made available with the final TA report. The report will be in three parts:

- Part I will present a summary of findings similar to Chapter 3 in <u>Energy From the West</u>.

- Part II will consist of six chapters, each of which will begin with a brief description of the technology-site combinations analyzed in a site-specific scenario. This will be followed by a report of the results obtained in four impact categories: air; water; social/economic/political; and ecological. A final section will summarize impacts for the scenario.

- Part III will be a single chapter which describes impacts for the eight-state region. The first section will describe how the eight-state scenario was constructed, the assumptions that were made, and how the analyses were performed. The second section will report the results of our analyses in eight categories: air; water; social/economic/political; ecological; health effects; transportation; noise; and aesthetics. A final section will summarize the impacts of energy resource development in the eight-state area.

This report is being issued as a part of the background and supporting materials because many readers will want more than the summary of impacts that will be presented in the final TA report. Some users will find the analytical structure and approach useful in organizing their own analysis of other developments.

4.2.3 Policy Analysis Report

The policy analysis report is intended to achieve three objectives. First, to identify the context within which energy resource development problems and issues will be dealt; second, to analyze the most significant problems and issues associated with energy development; and third, to integrate the results of each category of issues in order to identify inter-relationships among issues and among alternatives, and to provide an overall assessment of how issues can be dealt with.

The policy analysis report will also be made available as a part of the background and supporting materials for this study. As is the case of the ERDS report, a major reason for making these more detailed analyses available is that they permit readers to probe more deeply into the structure and conduct of our research; and some users will be interested in having access to more in-depth information about selected problems and issues than we will be able to include in our final TA report.

4.2.4 Data and Research Adequacy Report

A report describing the adequacy of current knowledge about the effects of energy development and analytical tools for analyzing these effects is a requirement specified by the Environmental Protection Agency (EPA) for this project. In meeting this requirement, prescribed research and data gathering activities will be related to the research that is already being conducted in-house and externally by federal and state agencies, and private organizations. Specific topic areas included are:

- o Air quality research, including information about existing conditions and models of the behavior of primary and secondary pollutants on both a local and regional basis;

- o Water quality and quantity research, including assessments of both institutional and natural factors that affect surface and groundwater in relation to energy technologies and population growth;

- o Social, economic, and institutional research, including data gathering and model development useful in predicting the responses of a selected variety of societal variables to the demands and outputs of new energy facilities;

- o Ecological and health effects research useful in predicting the effects of energy development on critical components of individuals, populations, and ecosystems; and

- o Integrating methodologies and strategies useful for organizing, assessing and predicting the effects of technologies and social policies.

The objective of organizing and assessing these research topic areas is to provide a broad overview of knowledge gaps to assist EPA and other agencies in planning research programs. Specific objectives include:

- o Identifying the present and potential gaps in theory and data which impede or reduce the reliability, effectiveness, and accuracy of related Technology Assessments.

- o Describing new research programs and specific research needs in order to minimize these information inadequacies; and

- o Describing how new research programs could be related to existing programs and identifying mechanisms for conducting or managing this research to make the products more useful to policymakers.

The report is to be based on three principal sources of data: (1) data and research limitations identified in the course of performing this TA and on file with members of the research team (some of which are also indicated in findings that are published in Energy From the West); (2) reports of research adequacy and needs studies conducted or sponsored by organizations such as EPA, the Energy Research and Development Administration and Federal Energy Administration (both now incorporated into the new Department of Energy), Office of Technology Assessment, and the Electric Power Research Institute; and (3) interviewing and/or communicating with program managers and researchers at major federal energy and environmental laboratories. The report will consist of four major sections:

- An introduction and summary of the TA that establishes the context of the research needs report;
- An identification of the specific knowledge limitations and descriptions of the tools, theories and methodologies needed to fill these gaps in categories such as air, water, social/economic/political, and ecology;
- An analysis of why the information needs and inadequacies exist and their relationship to integrative research, including a description of managerial arrangements to facilitate research; and
- A summary description of the relationship of research recommendations and existing programs, including an assessment of research priorities.

4.2.5 Information File Report

During the conduct of the TA, a large number of reports, papers, books, journal articles, and documents have been collected, catalogued, and indexed. In order to make this extensive information file easily accessible, a keyword index has been devised. As each document has been received, it has been catalogued, abstracted, and keyword indexed. At the conclusion of the project, an Information File Report will be prepared which includes: (1) a copy of each abstract, (2) a copy of the keyword index, (3) a copy of the computer program written to provide a matching bibliography for each keyword or combination of keywords, and (4) a copy of the input information and keywords. With these materials, literature searches can be made quite easily.

4.2.6 Subcontractor Reports

In addition to the subcontractor reports described earlier, reports on the water analyses described in Chapter 2 and identified as being performed by Radian and Water Purification Associates will be published as separate reports.

4.3 FINAL TECHNOLOGY ASSESSMENT REPORT

We now anticipate that the final technology assessment report will include the following:

1. A list of highlights of our major findings and where they can be found in the report;

2. A brief description of the background of the study, its purpose, why EPA sponsored it, by whom and how it was conducted;

3. A brief description setting the context of western energy development;

4. A summary description of the technologies, locations, and levels of development assessed;

5. A summary of impact analysis results;

6. A summary of policy analysis results;

7. A summary of the research needs and adequacy report;

8. An index and selected bibliography; and

9. An executive summary.

This report is intended to integrate the more detailed descriptions, data bases, and analyses reported in the background and supporting materials reports described above. The integration is shown graphically in Figure 4-1.

4.4 TIMETABLE FOR COMPLETING THE PROJECT

The final TA report is due on June 30, 1978. The schedule to produce this report is shown in Figure 4-2.

This general schedule does not show all the preliminary drafts that are to be reviewed internally and recycled continuously. In the case of the policy analysis papers, two review sessions are held every week to facilitate communication among team members, to insure that the team benefits from an interdisciplinary perspective, to identify overlapping problems and

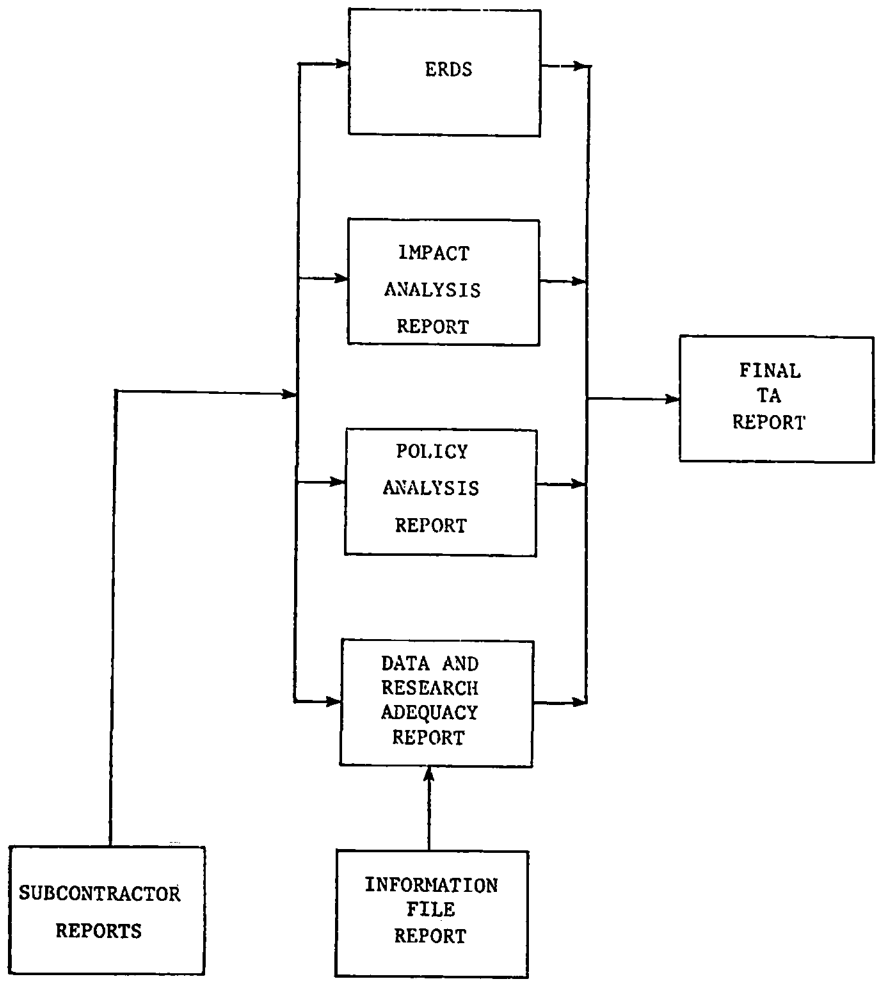

FIGURE 4-1: INTEGRATING BACKGROUND AND SUPPORTING MATERIALS INTO THE FINAL TA REPORT

issues, and to refine problem and issue definitions. The interdisciplinary group approach being used in this TA is described in our First Year Work Plan[1] and Energy From the West.[2]

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[1]White, Irvin L., et al. First Year Work Plan for a Technology Assessment of Western Energy Resource Development. Washington, D.C.: U.S. Environmental Protection Agency, 1976. (EPA-600/5-76-001, NTIS Order #PB-252 034/AS)

[2]White, Irvin L., et al. Energy From the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, 4 vols. and Executive Summary. Washington, D.C.: U.S. Environmental Protection Agency, 1977. (EPA-600/7-77-072a-d)

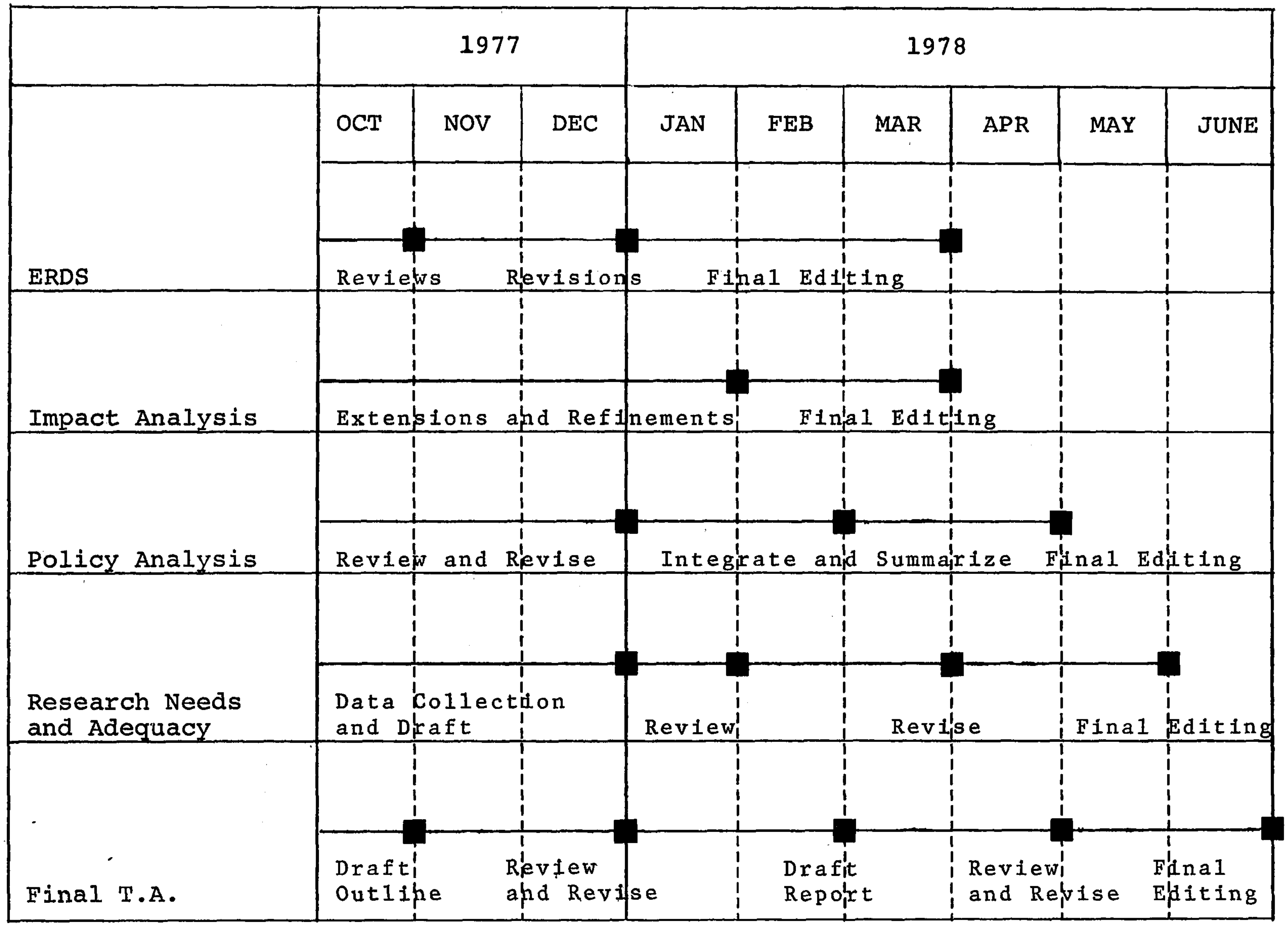

FIGURE 4-2: TIMETABLE FOR COMPLETING PROJECT REPORTS

CHAPTER 5

REGIONAL ACTIVITIES AND UTILIZATION

5.1 INTRODUCTION

From the beginning of the project, the research team has attempted to establish and maintain contact with a wide range of interests in the region, the energy industry, and local, state, and federal officials. These efforts have included traveling within the eight-state study area, communicating by letter and telephone, and circulating draft and final work plans and progress reports. These efforts are intended to provide feedback which will help us to improve our research products and are intended to insure that our results will be used. In this sense, then, these activities are the beginning phase of utilization activities. This element of our approach might very well be called "participatory research."

5.2 UTILIZATION AND FEEDBACK EFFORTS

Our efforts to secure interaction and feedback from interested parties and to promote utilization of our research products are described in four categories.

- Circulation of Reports. We will continue to circulate draft and final reports widely in an attempt to insure effective communication with those who can help us to avoid debilitating errors. Also, by a continuing process of widening our circle of contacts, we increase the likelihood of reaching those people most interested in and able to use our results.

- Travel in the Eight-State Study Area. Beginning in the Spring of 1977, members of the research team started specializing in their regional travel and contacts. At least one member of the team now has specific responsibility for maintaining communications with each of the states in the study area. In some cases, travel within the region is combined with the organized meetings described below; in others they include visits with industry, interest groups, local and state officials, and federal agencies. Some travel associated with professional and topical meetings is also continuing.

- Meetings with Local Officials. Starting in March 1977, meetings have been conducted with local officials, primarily mayors and county commissioners, in the vicinity of each of our local scenarios. Presentations have also been made to professional staff from the town, counties, and councils of governments. The face-to-face contacts made onsite now provide a basis for continuing feedback by phone and letter. Further visits are planned to present the results of the final analysis of the study.

- Meetings with State Officials. An approach similar to the local visits has been initiated with state officials, both administrative and legislative. This activity will continue until the project is completed.

*U.S. GOVERNMENT PRINTING OFFICE:1978 720-335/6043 1-3