BIBLIOGRAPHY

OF

SELECTED REPORTS

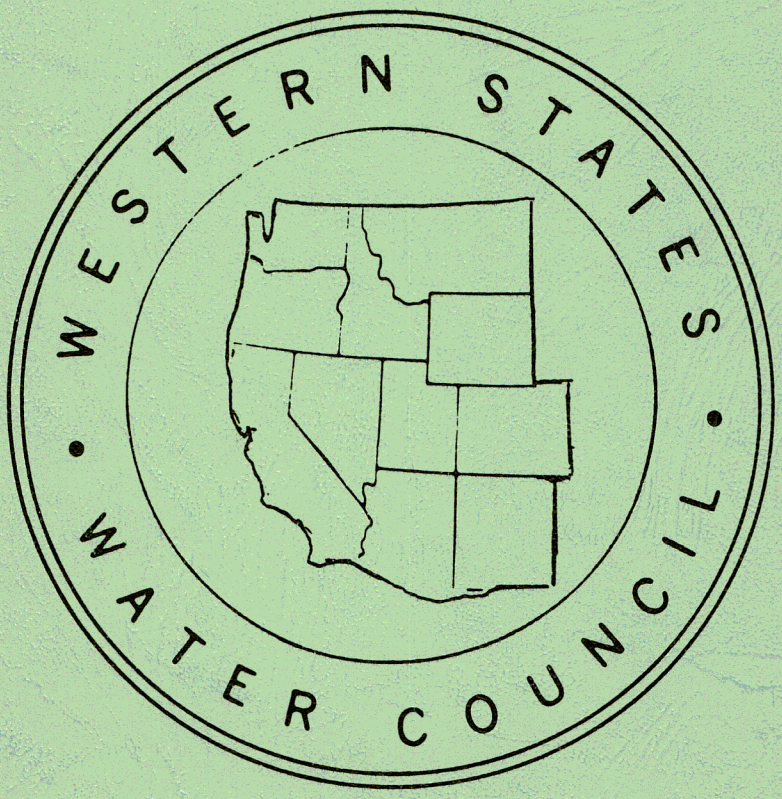
AND

ONGOING STUDIES RELATING TO

WATER REQUIREMENTS

FOR

ENERGY RESOURCE DEVELOPMENT



BIBLIOGRAPHY OF SELECTED REPORTS AND ONGOING STUDIES RELATING TO WATER REQUIREMENTS FOR ENERGY RESOURCE DEVELOPMENT

Western States Water Council
220 South 2nd East
Salt Lake City, Utah
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CONTENTS

INDIVIDUAL SUMMARY REPORTS FROM THE ELEVEN WESTERN STATES AS MEMBERS OF THE WESTERN STATES WATER COUNCIL

1. INTRODUCTION

1a. Scope and Purpose

It is acknowledged that there is a potential need for water for energy resource development in the Western United States that may exceed projections made a decade ago. The demand for western water may may be significantly impacted by decisions of the Federal Government as efforts are made to implement the announced "Project Independence." As an indication of the interest and concern of the governments of the eleven Western States, the Western States Water Council did enter into a study and prepare a publication entitled, "Water for Energy Resource Development in the Western United States to 1990." This publication was printed in November 1974.

In recent months, there has been initiated by federal, state and local governments, as well as the private sector, a multitude of study efforts to analyze ways that energy resources can be developed and utilized to provide the necessary energy for this nation in the decades ahead. These efforts have been accelerated by energy shortages and the declared desire of this Nation to become energy self-sufficient.

Many of these study efforts directly or indirectly relate to the potential need for western water resources. The Western States Water Council has found that in most cases, these study efforts are often uncorrelated. There is a lack of a total knowledge of the study efforts that are ongoing. For these reasons, the Council determined that it would be of value to Council members and to the eleven Western State Governments to have a bibliography prepared to identify some of the significant ongoing efforts. The Council also senses that this information may be of value to others involved in energy and water for energy efforts.

It is acknowledged that this report can only be a status report. Many of the studies that are identified as being in progress in the bibliography are just being completed or will be completed within a few months. Additional study efforts will continue for a year or more while others will start shortly after the completion of this summary effort.

It is acknowledged that a complete search is not possible and some important study efforts may have been overlooked by this compilation. It is further acknowledged that there were identified, many efforts more specifically related to a particular energy resource development that were not listed in this compilation because it was determined that these study efforts, were not directly related to demands on water resources. These omissions, although calculated, are based on judgement and in some cases, some were added and some were deleted simply to give the reader a small sampling of the multitude of information that may be available on the fringe or external from the main thrust of this study effort.

1b. Description of Study Efforts

The preparation of this bibliography was conceived and recommended by the Water Resources Committee of the Western States Water Council. At a meeting on December 18, 1975 in Denver, Colorado, the Water Resources Committee instructed the staff of the Western States Water Council to proceed with the effort. The Western States Water Council met in San Diego, California on January 16th and endorsed the preparation of this report and the issuance of said report to appropriate individuals and agencies that are concerned about the availability of water resources for energy resource development.

The report is primarily a staff effort, begun in late December of 1975 and concluded in late February 1976. The major staff responsibility was delegated to Jack A. Barnett, Executive Director and Fae Drake, Report Specialist for the Western States Water Council. Many of the contacts and initial research efforts were accomplished by Scott Ahlstrom, an engineering student. Advice and suggestions were provided on the report by Larry Wilkinson, an energy consultant from Salem, Oregon.

Some of the information in the report was abstracted from the library of the Western States Water Council. Additional information was obtained from material supplied by various investigators to the Western States Water Council in the form of studies and abstracts. Some of the information is exclusively a result of telephone contacts. In all cases, additional information as to names, addresses, phone numbers and further details concerning individual study efforts can be obtained by contacting the staff of the Western States Water Council.

Because there is a multitude of potential organizations to inventory and because the report deals with a dynamic subject that is constantly changing, the research effort could not, at any point in time, be considered complete. Therefore, it was determined that after an approximate two-month effort, the information available would be tabulated and printed in the following report so that information, as current as possible, might be provided to the interested reader.

1c. Categorization of Studies

The study efforts identified in the report have been categorized by the agency, organization or company responsible for the study effort. Reports and study efforts prepared by federal agencies are first identified, then reports by multi-governmental organizations are listed followed by specific state agencies and private organizations. A sample of academic efforts follows. Following the identification of academic studies, there is a brief summary prepared by each of the eleven western states, identifying in general the water for energy efforts that are occurring in the states. The last heading of the report identifies some short reports, articles, speeches and other information that did not seem to readily fall into any of the above identified categories.

In the case where a study may have been funded by one agency and conducted by another agency or private organization, the report is described under the funding agency but there is a cross reference to allow the reader to note that a study effort has been made by the contracting organization.

The last entry in the report is an index that allows a reader to, by subject area, identify the reports or studies that are listed in the bibliography.

2. AGRICULTURE DEPARTMENT

2a. "Development of Coal Resources in the Eastern Powder River Basin of Wyoming" (see Bureau of Land Management study

2b. "Energy Requirements of Environmentally Influenced Decisions Involving Water Development and Use"

This study performed for the Department of Agriculture by the California Agricultural Experiment Station of the University of California at Davis, looks at the energy requirements that are associated with solutions to problems of water development and use, waste water disposal, reclamation and reuse, water quality control including desalting and drainage. This project was funded in fiscal year 1975.

2c. "Chemistry and Soil-Water-Plant Relationships of Disturbed Lands and Their Effects on Revegetation"

This study addresses the problem of rehabilitation of many of the potentially disturbed soils in Montana as a result of future coal strip mining operations. It hopes to develop methods of land surface modification to enhance snow accumulation and reduce surface runoff. The study started in October 1975 and is to be completed by October 1980. The U.S. Department of Agricultural Research Service anticipates spending $80,000 in this research effort.

3. ATOMIC ENERGY COMMISSION

3a. "Heat Sink Design and Cost Study for Fossil and Nuclear Power Plants"

The advanced Engineering Department of the United Engineers and Constructors, Inc., prepared this December 1974 report. It is a comprehensive design and cost study for three wet tower systems, two pond systems, two dry tower systems, and a basic once through cooling system, one of which could possibly serve as a cooling system for both a fossil or nuclear power plant. The objective was to provide cost and design information for these cooling system alternatives as a basis for cooling system comparisons, evaluations and cost projections of power plants. The water consumption requirements for each system is given.

3b. "Economics of the Use of Surface Condensers with Dry-type Cooling Systems for Fossil-Fueled and Nuclear Generating Plants"

This December 1973 report presents the results of studies made by R. W. Beck and Associates of Denver, Colorado concerning the economic and engineering aspects of using surface condensers with dry-type cooling systems in place of direct contact steam condensers. Topics such as "Cost of Water" and "Water Supply" were briefly discussed.

4. CONGRESS

4a. "Energy Policy and Conservation Act"

The Energy Policy and Conservation Act of 1975 (P.L. 94-163) relates to the conservation of energy. The implementation of this Act could have far reaching effects on the total need for water for energy research development. Those wishing additional information on the Act can refer to the Conference Report published by the United States Congress as Report No. 94-516.

4b. "Water and Energy Self-Sufficiency"

This thick government document printed in 1974 (serial no. 93-52 (92-87)) for the use of the Committee on Interior and Insular Affairs contains a short introduction and then excerpts from many studies conducted on the water requirements for energy purposes. They are grouped under four main topics. (1) water needs for energy production, (2) energy resource development in the Northern Great Plains, (3) oil shale and (4) reclamation.

4c. "Water Resources for Energy Self-Sufficiency"

Dr. Daniel A. Dreyfus, Deputy Staff Director of the Committee on Interior and Insular Affairs in the United States Senate, prepared remarks for presentation before the National Capitol Section of the American Water Resources Association on September 18, 1975. This speech deals with the availability of water for energy purposes and contains estimations of the needs for water on a national level. Two major geographical regions receive special attention, the Colorado River Basin and the Northern Great Plains.

4d. "Water and Energy Self-Sufficiency"

Dr. Daniel A. Dreyfus, Deputy Staff Director of the Senate Committee on Interior and Insular Affairs, prepared remarks for presentation at the annual meeting of the Interstate Conference on Water Problems, October, 1975. The speech centers around two major areas of inquiry, (1) what kind of water problem does the energy crisis pretend and is there enough water for energy needs; and (2) what are the commitments of the national government on water for energy?

4e. "Non- Nuclear Research and Development Act"

This Act (P.L. 93-577) passed in November 1974, contains a section on water resources. It requires that specialized studies be made with respect to water when ambitious energy studies are being done.

4f. "Congress and the Nation's Environment"

This analysis prepared by the Congressional Research Service is an effort to document the legislative achievements of the 93d Congress in the area of resource and environmental programs. Individual chapters cover the legislative and policy activities of the 93d Congress in the resource categories, namely: energy and fuels; mines and minerals; land use policy and planning; public lands; water resources; parks, recreation and wilderness; forestry; fisheries and wildlife conservation; appraisal of natural resources supply and demand; the urban environment; government reorganization for energy; environment and natural resources; and natural hazards.

4g. "Water Resources Research and Technology Development Act of 1975"

A hearing before the Subcommittee on Energy Research and Water Resources considered S. 1301 which was written to promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of Interior. The short title for the bill is, "Water Resources Research and Technology Development Act of 1975". Contained within the proceedings and testimonies of the hearing is a listing of current research being sponsored by the Office of Water Research and Technology. Under the title, "Energy Water Relationships" are 69 projects currently supported at a funding level of $2,546,058.

4h. "Understanding the National Energy Dilemma"

This report published in 1973 by the Joint Committee on Atomic Energy contains a graphic presentation which enables a person to obtain a reasonable understanding of the broad problems, scale, and complexity of the energy dilemma. The report was prepared at Georgetown University. A visual display also projects the future effects of various energy policies on our domestic energy situation. The graphs show the energy requirements of the nation in 1950, 1960, 1970, 1980, and 1990. Efficiency, the end uses of the energy, the form use of the energy and supply v. demand are also included within the graphs. An update of this report is a new study prepared by Georgetown University and is referred to in this publication under the University.

4i. "Coal Slurry Pipelines"

The House Committee on Interstate and Foreign Commerce requested of the Transportation Program of the Office of Technical Assessment of the United States Congress that a study be conducted concerning coal slurry pipelines. The objective of this study is to assess the use of slurry pipelines for the transportation of coal with particular emphasis on the net energy cost, environmental effects and the impact of coal slurry pipeline transportation on the economics of railroads. It is anticipated that a final report will be prepared in December, 1976 and that hearings on the report will be held in 1977. Currently, there is budgeted $128,000 for the 1976 fiscal year and $24,100 for the transition quarter.

4j. "Coal Slurry Pipeline Legislation - Hearings"

Hearings were held before the Committee on Interior and Insular Affairs of the House of Representatives in March, April, May, June, July, September, November, and December of 1975, concerning H.R. 1863, H.R. 2220, H.R. 2553, and H.R. 2986. These House bills all relate to coal slurry pipeline considerations. The information gained by the Committee at these extensive hearings has been printed and is now available at the U.S. Government Printing Office. The 1253-page report is identified by serial no. 94-8.

5. CORPS OF ENGINEERS

5a. "Hydroelectric Power Potential at Corps of Engineers Projects"

The U.S. Army Corps of Engineers Institute for Water Resources has published a report entitled, "Hydroelectric Power Potential at Corps of Engineers Projects." The report has been given the number 75R1 and was published in July, 1975. The Institute for Water Resources is located at Fort Belvoir, Va.

5b. "Potential Hydro Power Development"

The Office of the Chief Engineer of the Army Corps of Engineers has published a report on the potential for hydro power development in the nation. This report can be acquired by writing directly to the Chief Engineer's office in Washington, D.C. It was released in February, 1976.

5c. "Pumped Storage Inventory of the Pacific Northwest"

The Seattle District of the Corps of Engineers has published a report that analyzes the potential for pumped storage in the Pacific Northwest. The report is identified as report No. 26 and was published in January, 1976.

5d. "Chief Joseph Additional Units Beyond 27"

A feasibility study is now in progress to analyze the potential for additional units beyond "Unit 27" in the Chief Joseph project of the Corps of Engineers. The report is being conducted by the North Pacific Division of the Corps of Engineers. Their offices are in Portland, Oregon.

5e. "Addition of Power at Lucky Peak Dam"

A feasibility report is in progress to analyze the potential for adding power facilities to the already existing facilities at Lucky Peak Dam on the Boise River near Boise, Idaho. The present facilities are used for flood control and irrigation. This feasibility study is due to be completed late in fiscal year '76 and it is hoped that a publication will be available in about September 1976. The study is being conducted by the North Pacific Division of the Corps of Engineers with offices in Portland, Oregon.

5f. "McNary Dam, Oregon - Feasibility Report for a Second Power House"

A feasibility study has been completed that analyzed the potential for additional power generating facilities at McNary Dam on the Columbia River. The report was completed in December 1974 by the Walla Walla District of the Corps of Engineers.

5g. "Regional Pump Storage Assessment"

A study is in progress that further analyzes the potential for pumped storage in the North Pacific Division of the Corps of Engineers. This study is being conducted by the North Pacific Division with offices in Portland, Oregon and it is expected that the report will be completed shortly as it is scheduled for completion in the 1976 fiscal year.

5h. "Willamette Project Review - Power"

This feasibility study that is now in progress analyzes in detail, the Detroit-Tumble Lake Pump Storage Project on the Willamette River. The study is being conducted by the North Pacific Division of the Corps of Engineers with offices in Portland Oregon. It is expected that the study will be completed in the 1978 fiscal year.

5i. "Power Potential of the Okanogan River and its Tributaries"

The Okanogan River and its tributaries located in the State of Washington are being studied by the North Pacific Division of the Corps of Engineers with offices in Portland, Oregon. The feasibility study is currently in progress and is intended to better analyze the potential for power generation in this river system.

5j. "Marysville Lake (Bar Park, California)"

This study has progressed past the feasibility stage and investigators are looking at the design for construction of additional power facilities at the already existing Marysville Lake project in California. This study is currently in the advance engineering and design state. The efforts are being conducted by the Sacramento District of the Corps of Engineers.

5k. "Flathead and Clarke Fork River Basin - Montana"

A feasibility study will be initiated in fiscal year 1977 to look at the potential for additional power generation on the Flathead and Clarke Fork Rivers in Montana. There will also be a review of past hydro power studies in that river basin. The study effort is being accomplished by the Seattle District of the Corps of Engineers.

5l. "Rio Grande River and Tributaries - New Mexico and Colorado"

A feasibility study is now in progress to assess the additional power potentials of the Rio Grande River and its tributaries. This study is being conducted by the Albuquerque District of the Corps of Engineers.

5m. "Missouri River, North Dakota, South Dakota, Nebraska and Montana"

This study in the Upper Missouri River Basin deals with over all water resource problems and the opportunities for including hydro electric power generation at existing facilities. Additional units may be possible that would increase capacities at three of the six existing projects on the Upper Missouri River. This study is evaluating the optimum size of additional units, the economic feasibility and the environmental and social impacts. The Omaha District will publish a report on the feasibility of increasing the size of existing units at the Fort Peck, Montana project. It is anticipated that this study effort will be completed by June 1, 1976. A separate report on the Garrison project is scheduled for completion at a later date.

6. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

6a. "National Energy Research Plan - Vol. 2"

This annual plan of ongoing studies was due for completion by mid-January. It is concerned with energy areas such as: solar, geothermal, fission,fusion, etc. It will contain information on time schedules, cost, who the sponsor is, and what the study effort involves.

6b. "Atomized Water Injection to Improve Dry Cooling Tower Performance"

This November 1974 report was prepared by Franklin Institute Research Laboratories of Philadelphia, Penn. Its purpose was to determine experimentally whether injection of atomized water can, in fact, lead to an improvement in air cooled heat exchanger performance, to determine the conditions in which fin wetting may occur and to develop the theory underlying the concept. This report also develops the basis for an economic evaluation of atomized water injection. Water flow requirements to achieve a given temperature are also included within the report.

6c. "Study of Dry-type Cooling Towers and Their Application to Large Nuclear Power Plants"

This 1974 report was prepared by Catalytic Incorporated of Charlotte, North Carolina. It discusses the feasibility of using dry-type cooling systems for nuclear power plants. Application of dry-type cooling systems in four specific areas are examined and evaluated. These areas are: (1) industry impact study, (2) protection of dry-cooling tower structures, (3) noise control, and (4) seismic design.

6d. "Northwest Regional Assessment of Energy Resources Including Water Resources in Coal Fields of Wyoming and Montana"

This report is presently underway and will be ongoing for several years. Its purpose is to determine the effect of potential energy development on environment, health and social life. The part of the report concerned with coal is being done in cooperation with other laboratories and together they are working on the long term development of coal. The region included in the report is Washington, Oregon, Idaho, Montana, Wyoming & Alaska. An annual progress report was to be completed sometime in January.

6e. "Assessment of Requirements for Dry Towers"

Battelle Northwest, located in Richland, Washington is presently doing this study. A handwritten draft of the effort was to be completed by mid-January 1976. This report will be available after it is estimated in two or three months. This report is the first semi-local look at the detailed whens and wheres of dry cooling. Based on the 1970 Power Survey, a distribution of 230 modified generation areas was set up. Power plants over a small area were clumped together. The water requirements for each of these areas were assessed up to the year 2000. Then this assessment was compared to the month by month availability of water in each of the 230 power groupings to see if the cooling requirements could be met. Therefore, (1) a look was taken at the potential of the river basins, and (2) the power projects were discussed. If sufficient water was not available, the possibility of dry cooling was investigated.

6f. "Nuclear Power Plant Cooling Water Treatment"

This study analyzed plant effluent discharges in an attempt to establish optimum methods of treatment of wet-cooling tower blowdowns. It also analyzed the cost differential between dry-cooling and wet-cooling towers for 1,000 megawatt nuclear power plants when various types of blowdown treatment is employed. The study was conducted for ERDA by Water Purification Associates at a cost of $47,000 with a completion date of March 31, 1975.

6g. "Assessment of Geothermal Resources of the U.S. - 1975" (see U.S. Geological Survey study 11f(33), page 21)

6h. "Purposes, Policies and Objectives" (see Water Resources Council study 17a, page 24)

7. ENERGY RESOURCES COUNCIL

7a. "Interagency Coordinating Committee"

This Council is composed of all cabinet secretaries who have to do with energy and resources and is directed by Frank Zarb. The purpose of the Council is to coordinate all energy efforts to arrive at a single voice position or a national policy that may be implemented at the federal level. Within the Energy Resources Council is the Interagency Coordinating Committee. Its purpose is to involve the state and local governments with the activities of the Council. State input to this Committee is by way of the National Governors' Conference.

7b. "Committee on Water for Energy"

There has been created within the Energy Resources Council a special committee to review the requirements of water for energy resource development. This committee is chaired by Jack Horton, Assistant Secretary of Interior for Water and Lands. The National Governors' Conference Task Force on Water for Coal Energy has met jointly with the representatives of the Energy Resources Council and it has been determined that these two committees will work closely together as they analyze water needs for coal. The first meeting, jointly of the two groups, was held March 29, 1976 in Denver, Colorado. The study efforts of these two organizations is yet to be completely defined.

8. ENVIRONMENTAL PROTECTION AGENCY

8a. "Optimizing Wet-Dry Cooling Towers for Water Conservation and Plume Abatement"

This project being done by the United Engineers, Inc., will assess the technical and economic feasibility of minimizing water use and reducing vapor plume discharges from wet-dry cooling towers.

The project requires two evaluations, (1) analysis of the technical and economic feasibility of minimizing water use by wet-dry towers for at least five sites within the Western United States. These analysis will include consideration of meteorology, water quantity, and water quality, and (2) analysis of the technical and economic feasibility of using wet-dry cooling towers for vapor plume abatement at five sites in the Western United States. The project began June 1975 and will terminate in July 1976. Up to $150,000 are available for the fundirg of the project.

8b. "Yellowstone-Tongue Water Quality Management Project"

This project is funded under Section 208 of P.L. 92-500. Most of the effort will be directed toward utilization of existing data for planning purposes with some new data collection. Consultants and government agencies will be given contracts to develop sewage treatment facility plans, ground water maps, land use maps, nonpoint source water quality data, and information on land use/water quality relationships. The project is being sponsored by the Environmental Protection Agency and managed by the Yellowstone-Tongue Area Planning Office. The total cost of the project is $540,000 and it is anticipated the project will take approximately two years, being completed on August 15, 1977.

8c. "Mineralogy of Overburden as Related to Ground-Water Degradation in the Strip Mining of Coal"

This study is looking at the change in groundwater characteristics that can be detected as they relate to the type of over-burden in strip mined areas. The study is sponsored by the Environmental Protection Agency and is being conducted by the Colorado School of Mines Research Institute. The $300,000 study was started in November 1975 with anticipated completion in approximately one year.

8d. "Effects of Surface Configuration in Water Pollution Control on Semi-Arid Mined Lands"

This study effort is funded by the Environmental Protection Agency and is being conducted by Montana State University through its Montana Agricultural Experiment Station. The study commenced on May 1, 1974 and is expected to be completed on May 1, 1978 at a total cost of $1,389,211. It analyzes reclamation and revegetation techniques and their effectiveness. It also looks to pollution effects from run-off of mined areas both in surface streams and groundwater supplies.

8e. "Power Plant Water Reuse and Waste Treatment"

This project being conducted by Radium Corporation of Austin, Texas will provide information on the design configuration and economics for minimizing water use and waste water discharges from coal fired, steam electric power plants. The project will entail the (1) collection of available data on composition and characteristics of waste from major plants process steams, (2) selection of plants for site specific studies (two in the West, two in the East), (3) preparation of process chemical equilibrium and plant simulation models, (4) determination of optimum water reuse and treatment design configurations, and (5) development of cost estimates for the optimum water recycle-reuse configurations. The project will provide the technical and cost information needed to proceed with the detail design construction and demonstration of water recycle-reuse projects at power plant sites. The project began in June 1975 and is to be completed by July 1976. $200,000 has been made available for the funding of the project.

8f. "Western Energy Resource Development"

The study objectives are: (1) to assist the Environmental Protection Agency in developing environmental control policies and implementing strategies for mitigating the adverse impacts of western energy resource development, (2) to assist EPA's Office of Research and Development in evaluating that portion of its environmental research program dealing with the problems of western energy development, and (3) to provide a balanced assessment of the full range of costs and benefits stemming from alternative energy resource developments in the Western United States in order to assist federal and state planners. Key study out-puts are (1) three technology assessments at one year intervals dealing with the ramifications of developing coal, oil shale, oil, natural gas, geothermal and uranium resources in the western states, (2) a research program evaluation report that critically compares the research required for adequate coverage of western energy related environmental issues and the current EPA research program in that area. The analysis of water availability will be primarily concerned with two topics: The Instream Water Quantity and the Process Needs of the Energy Resource Development System. An analysis of water availability will be made on two levels when possible. First a conceptual scheme will be presented to supply water to the particular process or group of processes under consideration. At this level of analysis, no connection will be drawn between the specific site and process under investigation and other possible developments either up-stream or down-stream. A second level of analysis will address a regional level

of development where several postulated energy resource development systems will interact and compete for the available water. This analysis will provide information that will help define the limits of possible energy development in a given region. Water requirements for municipalities, agriculture and secondary industry will also be analyzed in the evaluation of regional water impacts where possible water laws and compacts will be addressed as they create restrictions on water availability either in an absolute or distribution sense.

8g. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a. page 30)

8h. "Water Conservation and Pollution Control Alternatives in Coal Gasification and Liquefaction Processes"

This study, being conducted by Water Purification Associates for E.P.A. at three specific sites in North Dakota, Wyoming and New Mexico is a complete assessment of water requirements and treatments to be made for two coal gasification processes. It will look at water need for the production of solvent refined coal and for the generation of electricity via low btu gasification of coal and combined cycle generation. The study will include water for the process, water evaporated for cooling, water required for mining, water required for revegetation, and water required for all other on-site and associated off-site needs. Because of the aridity of the chosen sites, techniques for minimizing water consumption will be analyzed in detail. Complete water re-cycle and reuse will be emphasized with a value analysis of possible treatment techniques, both state of the art and innovative being included. Climatic and situational variations in water for cooling, mining and revegetation will be detailed, making this work the basis for future enlarging to determine state-wide, area-wide, and nation-wide water requirements. The Environmental Protection Agency has funded this project with $224,778. The project is to be completed Sept. 10, 1976.

8i. "Water Requirements for an Integrated SNG Plant and Mine Operation" (see Water Purification Associates study 59b. page 35)

8j. "Ground-Water Problems Associated with Potential Strip Mine Sites"

The Environmental Protection Agency is sponsoring this three-year study effort which is scheduled for completion June 1978. It is anticipated there will be collected, water flow and chemical data on selected mine spoils and that a model will be developed to simulate pre and post mining situations. The model will be used to simulate and predict flow quantities and qualities as alternate mining and reclamation techniques are evaluated. The $72,855 study is being conducted for the Environmental Protection Agency by the Montana Bureau of Mines and Geology.

8k. "Potential Impacts of Ground-Water and Surface-Water Quality and Quantity from Proposed Energy Development on the Northern Cheyenne Reservation - Montana"

This three year study sponsored by the Environmental Protection Agency is being accomplished by the Northern Cheyenne Research project with the Northern Cheyenne Tribe being the lead agency. It is desired to develop, indepth knowledge of the chemical and physical characteristics of the reservation water resources and the inter-relationship of water to other resources so that the tribe can make informed choices in making coal development. The project started on June 1, 1975 and is scheduled for completion on August 31, 1978. The cost of the project is $639,338.

8l. "Study and Monitoring of the Fort Union Basin - Water Quality"

Region VIII of the Environmental Protection Agency - the water quality of the Poplar River and the Tongue River will be studied with analysis of the chemistry of the water, the biology of the water, and the natural metals in the water to determine their effect on fish, aquatic life and other water organisms. The study is an anticipation of the development of coal resources in the area. The project was started June 1, 1975 and will be completed July 1, 1976 at a cost of $58,045.

8m. "Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development"

The National Resources Ecology Laboratory in Ft. Collins, Wyoming has started an investigation for the Environmental Protection Agency into the overall effects of potential toxicants on the aquatic environments resulting from coal and oil shale extraction and conversion. The specific objectives of the study are to identify and quantify those chemical products of coal and oil shale extraction and conversion which may reach surface waters and to determine by both field studies and laboratories by bioassays the degree to which chemicals may be acutely or cronically toxic to fish and aquatic invertebratesor may become involved as a part of the food chain. The project was started on July 1, 1975 and an interim termination date is June 30, 1976. The first year of study is funded at $600,000 but it is proposed that this study be continued at a total cost over a three-year period of $2,125,000.

8n. "The Effects of Surface Mine Configuration on Water Pollution Control on Semi-Arid Mined Lands"

The Environmental Protection Agency has contracted with the Montana State University to conduct a four year study on potential opportunity for water pollution control on mined lands. The objectives of the study are to demonstrate the effectiveness of several surface configurations that will control erosion, runoff, sedimentation and pollution. It is desired to quickly produce stable vegetative cover and create an equilibrium between precipitation, absorption and soil evaporation and transportation so that ground-water pollution will remain minimal. The study started on June 1, 1974 and is scheduled to be completed on June 1, 1978. The total expenditures will be $1,389,211.

8o. "A Cooperative Program to Evaluate Surface and Ground-Water Problems Associated with Potential Strip Mine Sites"

The Environmental Protection Agency is working in cooperation with Montana State University, Montana College of Mineral Science and Technology, the University of Wyoming, the University of North Dakota and North Dakota State University on this one-year project. The ultimate objective of the study is to identify possible impacts of coal mining and the development in the Missouri River Basin on the surface and ground-water systems of the surrounding areas. Three sites have been selected and all water in-flow and out-flow of the three study sites, one in Montana, one in North Dakota and one in Wyoming, will be analyzed. The characteristic of overburden from a physical and chemical point of view will be determined and its relationship to water coming to the surface will be analyzed. The characteristic of overburden from a physical and chemical point of view will be determined and its relationship to water coming to the surface will be analyzed. Ultimately, a model will be developed to determine, and eventually predict, the impacts of strip mining on surface and ground-water resources. The study, which is scheduled for completion on June 30, 1976 has been funded at $629,541.

8p. "Studies relating to Minimum Water Needs for Energy Conversion Facilities"

The Environmental Protection Agency through its Corvalis, Oregon facilities has three studies currently underway which will identify the minimum water needs for energy conversion facilities through water recycling - reuse and treatment and through the use of wet and dry cooling towers. These studies will provide design and cost information on alternatives for minimizing water consumption in power plants and synthetic fuel conversion plans.

8q. "Ecological and Social - Economic Impacts of Energy Development in the San Juan River Basin"

The Environmental Protection Agency has initiated a comprehensive study of the ecological and social economic impacts of energy development in the San Juan River Basin (Four Corners Region). In this study, there will be an assessment of the impact on (1) San Juan River quality and flow, and (2) off-stream water uses such as irrigation, drinking water and other uses.

9. FEDERAL ENERGY ADMINISTRATION

9a. "A listing of proposed, planned or under construction energy projects in federal Region VIII"

This report dated August, 1975 was prepared by the Subcommittee to Expedite Energy Development and the Social, Economic Impacts of Natural Resource Development Committee of Region VIII of FEA. The report includes energy projects in the States of Colorado, North Dakota, Utah, Wyoming, Montana, and South Dakota. It lists the project name, location, company, projected energy out-put, completion date, water requirements and source, and short remarks about each of the energy projects. These projects include proposed or planned coal mines, projected coal conversion plants, oil shale projects, potential coal slurry pipelines, tar sands projects, non-coal synthetic fuel conversion plants, and projected power generating plants. This report is being updated by the U. S. Bureau of Mines and the more recent study effort is referred to under that agency.

9b. "Government Role in an Oil Shale Demonstration Program"

This February, 1974 report describes methods of processing oil shale above ground and one method for processing underground. The expected incremental add-on of energy is given as well as the status of technology, project costs, timing and alternative programs. Energy impacts and environmental

impacts and costs receive additional attention. Finally, financing arrangements and government policies require to induce maximum industry participation, legal and legislative considerations, along with the governments role, are considered. General statements with respect to water requirements are made throughout the report.

9c. "Water Requirements, Availabilities, Constraints, and Recommended Federal Actions"

This report commonly known as Project Independence Blueprint was prepared by the U.S. Water Resources Council for FEA and was published November 1974. Its purpose is to identify and describe problems, plus recommend courses of action for securing the energy related water requirements of the nation along with other non-energy related water requirements.

9d. "Quarterly reports on the development of a water data bank"

A one-year, Federal Energy Administration contracted project is a joint effort between the Colorado Division of Water Resources and Colorado State University. The objective is to develop a water data bank and accompanying computer program that will serve as a tool for planners who undertake efforts like moving water from agricultural to industrial uses. Within the computer data bank, will be information on historic water uses, water rights, diversion, etc. The program will call the necessary data, process it and then identify what one wants to do. Evaluations of existing hydrological models, such as snow melt models, will be made to show the programs capability. This demonstration project focuses on the White River Basin area but does not attempt to solve the problems of that area. The $100,000 project will be completed in June, 1976 with a publication describing the system, its advantages and disadvantages, soon thereafter . Quarterly progress reports are available at the present time. Several conferences and a workshop are being considered to discuss the program and show how it can be used. A paper will be presented on this project at the Symposium in Boise, Idaho in May 1976.

10. FEDERAL POWER COMMISSION

10a. "National Power Survey-update"

This update of the 1970 survey is due for completion towards the middle of 1976 and will be three or four volumes in length. It will serve as a guide for future planning of the power industry.

11. INTERIOR

11a. Bonneville Power Administration

11a(1) "West Group Forecast of Estimated Loads and Power Resources"

The Bonneville Power Administration (BPA) is responsible for the distribution of power in the Federal Columbia River Power System (FCRPS). The FCRPS includes the United States Bureau of Reclamation and the U.S. Army Corps of Engineers facilities. It further includes the marketing efforts of BPA. Study efforts coordinated by BPA annually analyze the existing and future power needs within FCRPS. The Bonneville Power Administration meets with power consumers each year and collectively, they agree upon forecasts which are known as the West Group Forecast of Estimated Loads and Power Resources. These estimates include all of the power resources in the region. Therefore, the Federal system, public agencies and private utilities, hydro and thermal facilities are included. The forecast is published each year in the "Pacific Northwest Utilities Conference Committee - West Group Forecast of Power Loads and Resources." The annual report is published and available each year on about March 1.

11b. Bureau of Land Management

11b(1) "Development of Coal Resources in the Eastern Powder River Basin of Wyoming"

This May 1974 study is reported in two separate parts, a site specific analysis and a regional analysis. The regional analysis discusses the potential developments related to uses of coal for various energy purposes. Also, within the regional section, are descriptions of the existing environment, discussions of impacts, mitigating measures, alternatives to coal development, and irreversible and irretrievable commitments of the resources. The report discusses the water resources of the area and the water requirements of the region, considering the use of water by irrigation, reservoir evaporation,

municipalities, oil fields, power plants, gasification plants and slurry pipelines. The Department of Interior worked with the Forest Service of the Agriculture Department and the Interstate Commerce Commission on this effort.

11b(2) "Energy Minerals Rehabilitation Inventory and Analysis"

This Bureau of Land Management study involves an analysis of overburden as it relates to surface and sub-surface water hydrology and revegetation. The study will be conducted at designated sites that have been specified as reclamation study areas. The project was funded for the 1975 fiscal year at $804,500 and it has been funded again for the 1976 fiscal year for an additional $804,500.

11c. Bureau of Mines

11c(1) "A Listing of Proposed, Planned or Under Construction Energy Projects - update"

This project updates a previous effort and will list all proposed, planned or under construction energy projects in Federal Region VIII of FEA. The previous report was prepared by EPA and is listed in this publication under that agency. However, the update expands the area under consideration to all states west of the Mississippi. Energy projects included will be coal mines, liquefaction and gasification plants, oil refineries, geothermal projects, oil shale developments, etc. Since none of these will be existing at the publication date, it needs to be remembered that some may not be realized. More applicable, water requirements for the plant will be given. The summary should be available as a government publication near the first of June 1976.

11c(2) "Surface Mining and Water Resources in the Southwest"

This study addresses the problems that face those involved in mining operation in the reclamation of disturbed lands in arid regions where rainfall is often erratic. Surface configuration of the surface mined area is being studied so that the hydrology can better be understood as it relates to the mining effort. The Black Mesa area of Arizona is the subject study area. The study is being sponsored by the U.S. Bureau of Mines and is being conducted by the University of Arizona. The $57,500 study was commenced on May 23, 1975 and is to be completed on June 23, 1977.

11d. Bureau of Reclamation

11d(1) "Critical Water Problems Facing the Eleven Western States"

This report commonly referred to as "Westwide" was initiated in 1969 and was completed in April 1975. The report is published and supplemented by an Executive Summary. The goal of the study effort was to develop adequate information upon which a base for future significant decisions relative to water and related resources of the eleven Western States could be made. This report does not formulate plans. Rather, it recommends levels and areas of future federal involvement in water and related land resources planning. Some of the problems identified are water requirements for energy, municipal and industrial water supplies for small communities of the West, water supply aspects of wild, scenic and recreational rivers, meeting water demands through conservation and reuse, water requirements for public lands, the changing federal role in developing irrigation projects, water supply potentials from weather modification, water supply problems of the Colorado River, water requirements for oil shale development in the Upper Colorado Region, operation and management of the Columbia River Main Stem System to meet total water uses and conflicts of water use in the Hells Canyon Reach of the Middle Snake River. Specific problems in each of the eleven states are also identified. Typical of these are, water supply, water requirements to meet energy demands and water supply for population and economic growth.

11d(2) "Increased Energy Production in the Western States Through Wise Management of Water Resources"

This study was announced by Commissioner Gilbert C. Stamm of the Bureau of Reclamation in February 1976. It is intended to analyze the possible use of federal reclamation projects and canals to provide water for cooling thermal power plants. There will also be appraisals made of possible secondary uses of thermal cooling product waters such as warm water irrigation. The study will look at the opportunity to revise water and power operations to minimize power requirements for pumping or to maximize the generation of power so that there can be freed hydroelectric facilities for peaking purposes. An analysis will be made of the potential improvements in power transmission through consolidation of lines and exploration of joint ventures with private industry. Finally, the study will consider the possible

integration of other forms of energy with the production of hydroelectric power. The study, which will be conducted by the Bureau of Reclamation is estimated to cost $290,000.

11d(3) "Water Resources Planning and Engineering Research; Engineering Works - Electric Power"

Feeling that electric power research will continue to improve the efficiency and reliability of electrical power generation, transmission and control, these studies will look at high-voltage a-c transmissions, circuit breakers, central facilities, ac-dc converters, and system stability analytical studies. Also included will be studies on automated computerized system controls, new energy storage systems, controls for variable speed pumps used in pump-storage hydroelectric projects, criteria for regulating efforts between major entities, and noise abatement and safety factors for powerplant facilities.

11d(4) "Energy Research and Development Program - Pumped Storage"

This study began in 1975 with a completion date of 1981. The objective of this research is to improve efficiency, capability, reliability, and versatility of pumped-storage installations. The research will focus on use of variable-speed machinery for fluctuating head conditions, automated units and systems control, development of more efficient pump-turbines, reduction of draft-tube surging, and investigations of technical-economic feasibility through use of natural and manmade underground storage space of water and equipment.

11d(5) "North Platte River Hydroelectric"

This study is of the Upper North Platte River System. The investigation will appraise the potential for development of pumped storage hydro units at existing Reclamation storage reservoirs on the North Platte River. Also, the installation of an additional conventional hydro unit at the Fremont Canyon powerplant will be investigated. Investigation is to start in 1977 and end one year later.

11d(6) "Upper Colorado Resource Study"

The project is located in eastern Utah and western Colorado. The study will identify reasonable alternatives for meeting water requirements for the most likely projected levels of production of the oil shale tracts C-a and C-b in Colorado and U-a and U-b in Utah, provide municipal water to meet the needs of support population in both states, provide water for Ute Tribe Indian lands and non-Indian lands, and enhance stream fisheries and recreation values. Project is ongoing and will end in 1978.

11d(7) "Colorado River Storage Project Power Peaking Capacity"

This investigation will encompass the Upper Colorado River Basin and the eastern part of the Bonneville Basin along the Wasatch Front in Utah. Investigation purpose is to evaluate the potential for adding future peaking capacity at large hydroelectric power developments in the Upper Colorado River Basin in the eastern portion of the Bonneville Basin in Utah. The study is ongoing and should be completed in 1977.

11d(8) "Hoover Powerplant Modification Feasibility Investigation"

The site of this study is Hoover Dam on the Nevada-Arizona boundary. This investigation will determine the feasibility of adding hydroelectric generating units at Hoover Powerplant to increase its peaking capacity. The study is to begin in 1977 with completion in 1980.

11d(9) "Energy Research and Development Program - Geothermal"

This effort is aimed at the demonstration of the feasibility of concurrent production of desalted water and electric energy using geothermal fluids. The program is designed to use the Bureau's existing Mesa Test Facilities in the Imperial Valley of California as a test bed installation. Also because of the geothermal resources found at the Mesa anomaly, the program will concentrate on solving problems associated with use of the low-enthalpy geothermal resource.

11d(10) "Geothermal Investigations"

The prime objective of these investigations which are being conducted in the Lower Colorado Region; Boulder City, Nevada, is to establish the technical and economic viability of desalting geothermal brines to furnish auxiliary fresh water sources in water-deficient areas.

11d(11) "Geothermal Investigations"

Appraisal investigations to identify areas of water needs that would be met by possible geothermal development are being conducted in Arizona, California, Nevada, New Mexico, and Utah. An appraisal study scheduled for completion in FY '76 is now being conducted to evaluate the geothermal resources in the vicinity of Susanville, California. A study will also be conducted which will monitor the status of geothermal resource development in the mid-Pacific Region and maintain liaison with various State and Federal agencies as well as with utilities and other geothermal resource developers.

11d(12) "Molalla Division Feasibility Study"

The Willamette River Project, located in northwestern Oregon, lies between the Cascades and Coast Range Mountains and extends from the Calapooya Mountains on the south to the Columbia River on the north. Its length is about 150 miles and the average width is 80 miles. The Molalla Division is located in the sub-basins of the Molalla and Pudding Rivers, in Marion and Clackamas Counties, Oregon. All factors of multiple-purpose water and land use needs are being considered. The State Parks Division is interested in the possibility of developing storage above a state park on Silver Creek to add another recreation dimension to the park's uses. Local interest is directed through some 14 local committees which provides the Bureau with a sounding of local problems and needs and public opinion. Investigation was started in fiscal year 1965 and a report based on multiobjective planning guidelines is scheduled for completion in fiscal year '77. Alternate plans could include the building of the Dickey Dam Powerplant.

11d(13) "Western Energy Expansion Study"

This study will inventory and compare opportunities to increase energy capacity and generation through water management and development. The following purposes will be explored: (1) use of Federal project water for cooling thermal powerplants; (2) revision of water and power operations at existing facilities to minimize power needs for pumping or to maximize power generation, including the purchase of power to meet Federal pumping requirements, thus freeing Federal hydropower for peaking purposes; (3) energy conservation measures by Federal power users; (4) consideration of structural modifications and additions at existing power facilities; (5) identification of new hydro and pumped storage sites; (6) appraisal of secondary uses of thermal cooling product water such as warm-water irrigation; (7) use of waste water for thermal cooling; (8) prior utilization of known hydropower generating potentials for possible updated feasibility study authorizations; (9) improvement of power transmission through consolidation of lines, exploration of joint ventures with private industry, and impacts of new technology on interties and (10) consideration of integrating "exotic" forms of energy such as mineral energy, geothermal, solar, and wind and hydropower generation for use in and around major Western load centers. The study will be an interregional coordinated effort to compare potential energy development projects.

11d(14) "Minidoka Powerplant Rehabilitation and Extension Feasibility Investigation"

The primary purpose of this feasibility investigation is to evaluate the feasibility of rehabilitating or replacing the old power units and providing additional generating capacity at the existing Minidoka Powerplant on the Snake River in Idaho. The investigation is scheduled to start in 1977 with completion in 1980.

11d(15) "Grand Coulee Third Powerplant - Extension Feasibility Investigation"

This investigation started in 1975 and is scheduled for completion in 1977. It will determine the feasibility of providing additional units at Grand Coulee Third Powerplant as an integral part of Grand Coulee Dam and the Columbia Basin Project.

11d(16) "Appraisal Report on Montana, Wyoming Aqueducts"

This report presents results of extensive studies by the Bureau of Reclamation from 1969 through 1971 on the availability of water resources in Southeastern Montana and Northeastern Wyoming for the development of the vast coal resources in the region. The report presents results of studies of an aqueduct system and alternatives that would be required to convey water from sources to points of possible use.

11d(17) "Alternative Sources of Water for Prototype Oil Shale Development - Colorado and Utah"

The purpose of this September 1974 study is to identify specific alternative sources of water for use in prototype oil shale developments in west central Colorado and east central Utah. The study provided technical information on alternative water sources to the oil shale environmental advisory panel as it made recommendations on water developments for oil shale to the Secretary of the Interior. The report specifically identifies the availability of water to that area and the water requirements of the oil shale.

11e. Office of Water Research and Technology

11e(1) "Water Resources Aspects of Coal Transportation by Slurry Pipeline"

This study is being conducted by the Water Resources Research Center of the University of Arkansas for the Office of Water Research and Technology. The study identifies the fact there is a significant amount of low sulfur coal located in Wyoming, Montana and the Dakotas and that there is a limited availability of water supply in the area of the coal deposits. The study looks at the potential for the deterioration of water quality that could be expected from the processing of the coal, the possibility of using water for low quality for the slurry water, and the treatment processes that might be required at both the in-take and out-fall area of the pipeline. This ongoing study is funded for the 1976 fiscal year at a cost of $54,817.

11e(2) "Optimization of Water Consumption and Cost of Cooling Towers for Power Plants by use of Combination Dry-Wet Towers"

This research effort was funded by the Office of Water Resources Research and Technology of the Department of Interior and was performed by the University of Iowa's Institute of Hydraulic Research. The study involved the design and economic feasibility in using a combination of cooling towers in which dry and wet cooling is carried out in different proportions in a single unit. The primary aim of the study is to investigate alternate methods of cooling in areas where there is a shortage of water quantities. The study was conducted in the 1975 fiscal year.

11e(3) "Hydrology of Madison Formation and its Potential use for Water Supply for Energy Development"

This study which was funded by the Office of Water Resources Research and Technology was conducted by the University of Wyoming's Water Resources Research Institute. This was a reconnaissance type investigation bringing together from a variety of sources, the hydrologic information that was available concerning the Madison Limestone. Once the data was collected then calculations were to be entered into that would simulate recharge discharge characteristics of the acquifer. The funding in the 1975 fiscal year was $10,000.

11e(4) "Estimation of Amenity Values as Opportunity Costs for Energy-Related Water Use in Montana"

The objectives of this study is: (1) to develop, and (2) apply the test methodologies with which to evaluate the in-stream recreation and aesthetic values of waters being considered for consumption by energy conversion operations in Montana. The study is being sponsored by the Office of Water Resources Research and Technology and being conducted by Montana State University. The one-year study started on March 1, 1975 and is expected to be completed on March 31, 1976 at a total cost of $66,458.

11e(5) "The Importance of Energy-Related Water Demands in Developing Regional Water Resources - an Optimization Approach"

This is a methodology study conducted by the University of Illinois Institute for Environmental Study to determine optimum ways of allocating regional water resources for use in coal gasification plants and new power plants. The study was conducted with the aid of a mathematical model. It was funded during the 1975 fiscal year.

11e(6) "Use of Brackish Water for Coal Gasification"

This federally funded project was performed by the New Mexico State University School

of Engineering. It is proposed that large quantities of New Mexico coal be used for gasification. These processes require a significant amount of water and the study effort was aimed at determining if brackish water could be used when available so as to save the fresh water supplies. The project was funded in fiscal year 1975.

11e(7) "Energy Demand and Water Resource Management - The Economic Aspects"

This federally financed project was performed by Cornell University's School of Agriculture. The study forecasted the magnitude of possible regional water deficiencies or use conflicts due to increasing energy demands and it estimated the relative economic impacts of alternative water resource management policy options. A major focus was to develop a regional water allocation and investment decision making model incorporating energy related water demands. The study effort was funded in the 1975 fiscal year.

11e(8) "Impacts on Agricultural Land Use, Income, and Employment Resulting from Water Transfers to Facilitate Oil Shale Development"

The expected development of an oil shale industry in Colorado, Utah, and Wyoming could utilize large quantities of water in the production and processing of shale as well as building and maintaining new communities that would be required. The water of the region already is scarce. The study looked at programs and policies that might be necessary to facilitate resource adjustments with a focus upon alternate arrangements for water transfers. In the 1975 fiscal year, $19,460 were provided for the Utah State University's Economic Research Center to perform this study effort for the Dept. of Interior.

11e(9) "Coordinating Water Management and Energy Development Strategies in the Upper Colorado River Basin"

This study was conducted by the Colorado State University's School of Agriculture for the Office of Water Resources Research and Technology. This study analyzes the effects that development of various energy resources in the Upper Colorado River Basin might have on water qualities, water rights, salinity control administration problems and water management and energy development strategies. The effort attempts to formulate a decision making process wherein the use of water resources could be maximized for the region. This project was funded in the 1975 fiscal year.

11e(10) "Water Resources Research and Technology Development Act of 1975" (see Congress study 4g, page 4)

11e(11) "Coal Energy Development in the Northern Great Plains"

A portion of the above report was funded by the Office of Water Resources Research and Technology. The water study portion is divided into two parts: Water Resources and Water Quality. Work in progress is reviewed separately for each section. Attention is given to water planning models, water availability and water requirements and options.

11f. U. S. Geological Survey

11f(1) "Availability of Water from the Madison and Associated Limestones in the Powder River Basin"

This project finished in October, 1975 was to evaluate the data describing the aquifer, to improve the conceptual model, test the model to refine the concepts and develop a reliable understanding of the aquifer. With this knowledge, the project planned a drilling and testing program of the Madison aquifer for fiscal years 1976 and beyond.

11f(2) "Evaluation of the Madison Limestone Aquifer"

On February 5, 1976, the U.S. Geological Survey formally announced that it will study, in detail, the availability of groundwater in an 188,000 square mile area of the Powder River Basin. This includes parts of Montana, Wyoming, Nebraska, North Dakota and South Dakota. The study plan takes advantage of three existing reports. It has been concluded that an additional 5-year study effort is needed and that some period of time is required for deep drilling and evaluation of the Madison Aquifer. The first year appropriation for the study is $2 million. The already published reports that are used as background are: (1) U.S.G.S. Open File Report No. 75-631, "Plan of Study of the Hydrology of the Madison Limestone and Associated Rocks in parts of Montana, Nebraska, North Dakota, South Dakota and Wyoming, (2) U.S.G.S. Open File Report No. 75-660, "Water in the Madison Group Powder River Basin, Wyoming and Montana," and (3) U.S.G.S. Water Resources Investigation Report No. 63-75, "Preliminary Digital Model of the Ground-Water Flow of the Madison Group, Powder River Basin and Adjacent Areas - Wyoming, Montana, South Dakota, North Dakota, and Nebraska." The present 5-year study effort is under the direction of project supervisor Elliott Cushing, a U.S.G.S. Hydrologist, headquartered in Denver,Colo.

11f(3) "Estimated Use of Water in the U.S. in 1970"

The U.S.G.S. makes a periodic 5-year update of estimated use of water in the United States. This report is the latest of this series. However, the updating job for a current report should get underway shortly and the final updated report should be available by the end of 1976.

11f(4) "Water Demands for Expanding Energy Development"

This 1974 Circular 703 focuses on whether water supplies will be sufficient to support accelerated energy development foreseen in Project Independence. Areas of consideration are: coal mining, oil and gas production, uranium mining, oil shale mining, slurry pipelines, refining of energy fuels, conversion of energy raw material into a more useable form of energy, steam electric generation, oil shale conversion, coal gasification, and coal liquefaction.

11f(5) "Effects of Strip Mining on the Hydrology of Small Watersheds in the Black Mesa Area of Arizona"

The study analyzed the effects of strip mining in three watersheds of 400 acres each. It was proposed that the overall efforts of this study effort be expanded to analyze the 35-year mining operation effect in the Northeastern corner of Arizona on the water resources of the area. The study was conducted by the U.S. Geological Survey in 1974 and 1975 with an expenditure of $49,500. The U.S. Geological Survey has announced a continuation or expansion of the study that will further analyze the impact of mining and related activities on the watershed by hydrologic monitoring. It is anticipated that the expanded study will be completed in June 1982 at an estimated cost of $319,564.

11f(6) "Yampa River Basin Assessment Study -- An Evaluation of Energy Development Alternative Factors on the Environment"

The primary objective of this study is to evaluate possible alternative futures for development of economic resources of the Yampa River Basin within existing and feasible alternative policies and institutional arrangements dictating or influencing basin development. It is anticipated this study will assist other energy-rich, water-poor regions in the Western United States. This project began in April of 1975 and will be completed about October 1976. The cost is estimated at $214,120.

11f(7) "Rehabilitation of Mined Lands, Southern Moffatt County, Colorado"

This project is a study to define the availability and quality of surface and ground water prior to mining and to predict the effects of these factors when strip and underground mining is underway and to monitor surface and groundwater through both phases.

11f(8) "Sediment Yield of Streams Draining the Piceance Basin, Northwestern, Colorado"

This three year study scheduled for completion in June 1977 is to define the sediment yield of streams draining the Piceance Basin and to lands that are scheduled to be mined. It is to define the sediment yield prior to mining. The data from this study will be used to determine the "natural" sediment yield of streams in the basin after oil shale mining begins. The project will collect data and define the

sediment yield of streams from mined areas to evaluate the impact of oil shale mining on sediment yield. Estimated total funding is $121,008.

11f(9) "Observation Well Drilling and Potentiometric Surface Mapping"

A three year project was begun in July 1974 to deal with the problem that oil shale development and associated mine dewatering would create by altering the existing steady-state geohydrologic conditions in the Piceance Basin. The study provides a baseline potentiometric data and monitors changes resulting from oil shale development. The data would be used to improve the calibration of an existing digital model of the ground-water system.

11f(10) "Piceance Basin Spring Hydraulics Research"

It is anticipated that large oil shale operations in the Piceance Basin area would intercept ground water springs that naturally discharge to the drainages of the area. Thus the objective of the study is to locate and determine the source of major springs in the Piceance Basin, determine their flow characteristics, and predict the effects of dewatering resulting from oil shale mining on spring flow. The Water Resources Division of the U.S. Geological Survey conducted the survey during 1974-75 at a cost of $66,989.

11f(11) "Geochemical Investigation of the Piceance Basin, Northwestern Colorado"

The project will define the variation in water chemistry in the aquifers of the Piceance Basin and its relationship to the soluble minerals of the Green River Formation. The study is to develop a digital model of the geochemistry which will be coupled with the existing digital model of aquifer hydraulics and use to predict the effects of oil-shale-mine dewatering in water chemistry. The estimated cost is $169,264.

11f(12) "Geophysical Logging, Piceance Creek Basin, Northwestern Colorado"

This project, due for completion in June, 1976, deals with the geologic framework of the Piceance Basin which controls the boundary conditions and hydraulic properties of the aquifer system. Data on the geology are needed to better define the aquifer system and its relationship to the oil shale resources of the Basin. Under this project, all new wells in the Piceance Basin will be logged to aid in the selection and description of future oil shale lease tracts and also to improve the description of the geohydrologic system. Estimated total funding is $27,707.

11f(13) "Aquifer Testing, Piceance Creek Basin, Northwestern Colorado"

This project objective is to define the regional variation of transmissivity and storage co-efficient of the two principal aquifers and the leakage through the confining strata of groundwater flow. The results can be used to evaluate the impact of oil shale development on the hydrology of the Piceance Basin. The estimated total funding is set at $258,047.

11f(14) "Hydrologic Surveillance of Coal-Lease Areas in Northwestern New Mexico"

Developments affecting areas of the San Juan Basin in Northwestern New Mexico such as strip mining of coal, oil and gas exploration, electric power generation, coal gasification, and agriculture may affect the condition of the water resources by changing drainage patterns, increasing sediment yield, and altering the chemical quality of the water. The above study, which began in August 1974 and is to be completed in June 1977, will collect adequate water-resources information to properly assess any changes in the water resources of the study areas and determine the causes. Information obtained will be used to interpret the regional effects of any changes. The two areas of the study are the Shumway Arroyo Drainage System near Fruitland, New Mexico and the Hunter Wash-De Na Zin Drainage System near Bisti, New Mexico. The study was funded with $100,000 in 1974-75 and the total funding is estimated at $295,027.

11f(15) "Effects of Energy Resources Development in the Hydrogeologic Environment of Northwestern New Mexico"

This long-term project is to evaluate the aquifers within the project area and determine those areas most suitable for groundwater development and waste disposal. The study is to determine ground-water levels for the various aquifers and form ideas on the effects of various degrees of withdrawals upon the water levels and determine the chemical and radio-chemical quality of the groundwater and surface water. The project began Aug. 1974 and is to be completed in June 1980 at a cost of $219,944.

11f(16) "Hydrologic Reconnaissance of Geothermal Areas in Oregon, Nevada and California"

The objectives of this study are to describe the hydrologic environment of several identified but unrelated geothermal resources in a three-state area and also to determine the recharge of these areas. This is the first phase in what is envisioned as a long-term investigation of numerous potential geothermal areas in all of the Western United States. The study was conducted by the Water Resources Division of the U.S. Geological Survey in 1974-75 with authorized funding at a level of $86,000.

11f(17) "Hydrologic Reconnaissance of Utah Coal Fields"

Project objectives are: (1) identify baseline conditions, surface-water availability, distribution in time and place, runoff characteristics and quality, sediment yields, groundwater recharge, movement, storage, discharge and quality (2) make quantitative estimates of water-resources quantity, availability, and potential for development (3) make semi-quantitative predictions, if feasible, of potential effects of proposed developments on water resources, and (4) recommend long-term monitoring network and additional detailed studies that may be needed. The project is subject to budget, personnel, and time limitations.

11f(18) "Hydrology of the Oil Shale Area, Uinta Basin, Utah"

Project objective is to design an investigation with objectives, individually and collectively, that may be attained within about five years at a minimum expenditure of funds. The investigation is to provide a series of data and interpretive reports that will provide a comprehensive analysis of the hydrology of the oil shale area, oriented toward problems of water supply and the impacts of oil shale development.

11f(19) "Hydrology of Potential Coal Strip-Mining Reclamation Site Near Kanab, Utah"

The project objective is to collect hydrologic data that are necessary to define present hydrologic conditions in the study area and to contribute an interpretation of existing hydrologic conditions in the study area. This data will be integrated into a joint report being prepared by the Bureau of Land Management. The project is also to monitor streamflow, water quality and sediment in principal streams in the study area during the interagency investigation.

11f(20) "Geothermal Reconnaissance of Southwestern Montana"

A geologic reconnaissance is being conducted by the Montana State University in cooperation with funding and sponsoring agency, the U.S. Geological Survey Water Resources Division, to determine the geothermal potential of Southwestern Montana. The first year of the study which started in June 1975 has been funded at $20,000. It is anticipated that two additional years of funding will be requested.

11f(21) "Impacts of Economic Development and Water Use on Water Resources in the Hanna Basin in Wyoming"

This project, to be completed in September 1978 is to describe the present characteristics of the hydrologic environment, to monitor changes in it and to evaluate the effects of those changes on the surface, peak and annual flows, channel geometry, sedimentation rates, erosion rates, uses, and quality and groundwater uses. Estimated funding is set at $111,517.

11f(22) "Water and its Relation to Economic Development in the Green River and Great Divide Basins in Wyoming"

This study is designed to gather and make available to interested industrial, agricultural, and governmental people, interpretive reports that describe: (1) the distribution and quality of surface water in space and time, (2) relationships between surface water and groundwater, (3) the distribution, quantity, and quality of groundwater, and (4) hydrology-related aspects of the environment. Efforts of the study will be directed towards: (1) describing the water resources and hydrologic relationships that presently exist, (2) developing predictive methods that may be used to describe future conditions, including reactions to increased water development, and (3) establishing monitoring programs for detecting possible changes in water parameters.

11f(23) "Water Resources of the Powder River Structural Basin in Wyoming in Relation to Energy Development"

This project is carried on in two phases. The objective of the first phase will be to determine the adequacy of existing data to describe water availability and assess possible impact of the pending development and to identify specific subjects that should be studied by the District. The findings of the first phase will be used to identify major thrusts for the second phase, which will constitute the program in the Basin during the succeeding four years. This study effort was funded with $115,500 during the fiscal year 1974-75.

11f(24) "Hydrology of Paleozoic Rocks in the Powder River Basin and Adjacent Areas, Northeastern Wyoming"

This project is designed to derive a conceptual model of the aquifer system to better predict the quantity and quality of water available from the paleozoic rocks and to predict some of the effects of its development.

11f(25) "Hydrology of the Madison Limestone and Associated Rocks in Parts of Montana, North Dakota, South Dakota, and Wyoming"

This study objective is to evaluate quantity of water that may be available from the Madison Limestone, define chemical and physical properties of the water, determine effects of existing developments on potentiometric head, storage, recharge and discharge, spring flow and stream flow, and pattern of groundwater flow, predict possible hydrologic effects of proposed withdrawals of water for large-scale developments at selected rates and locations, determine the better locations for wells and the type of construction and development of deep wells to obtain optimum yields, and design network of observation wells and streamflow gages to monitor effects of additional developments on the hydrologic system. The study began in December 1975 and will be completed prior to September 1980. Some estimates are that, with test drilling costs included, the total study effort could cost $8 million.

11f(26) "Measurement of Water Losses to the Madison Limestone and Associated Rocks from Streams in Northeastern Wyoming"

Because the Madison Limestone has been recognized as a potential future supply for water for energy resource development and because little was known as to the way in which the Madison Limestone is recharged by surface streams, this study was initiated by the Water Resources Division of the U.S. Geological Survey. The study effort was in 1974-75 and the project was funded at $194,400.

11f(27) "Potential for Large Industrial Water Development from Madison Limestone Underlying the Fort Union Coal Basin in parts of Montana and Wyoming"

Because there is not adequate surface water available on a dependable basis and because dams are costly, a study was instigated by the U.S. Geological Survey to determine the potential of the Madison Limestone in Montana and Wyoming. This $40,000 study was conducted in 1974 and 1975.

11f(28) "Hydrologic Effects of Surface Mining, Land Rehabilitation, and Land Use as Defined by Rainfall Simulation.

This study covers an eleven western state region and is intended to analyze the effect of land rehabilitation and land use that surface mining for coal may have on Bureau of Land Management administered lands. The investigation is being conducted by the U.S. Geological Survey. A total of $75,300 is to be spent in fiscal year 1976.

11f(29) "Water Resources Data for Some Potential Coal Mining Areas in Washington"

The basic objective of this study effort is to provide the basic water resources data necessary to (1) determine the feasibility of developing the coal deposits and (2) predict and monitor the effects of coal mining on the hydrologic environment. The basic water resources data are needed in the potential coal mining areas in order to evaluate: (1) the hydrologic problems involved in developing the coal, (2) the availability of water for producing or processing the coal, and (3) the environmental impact of the coal mining activity. The data collection which began in July 1975 should be completed by June 1977.

11f(30) "Geochemical Survey of Waters of the Western Coal Regions"

It is the goal of this project to efficiently provide data on the "natural" or pre-development geochemistry of the waters of the area, with particular emphasis on trace elements that may have a relationship to health and disease in humans or animals. If time permits, attention may also be given to quantifying changes already produced by existing developments in the area and the relationships between soils, plants, rocks, and waters, within the study areas. Estimated total funding is $124,116.

11f(31) "Sorption of Residual Organic Substances in Retort Waters by Spent Oil Shale Residues"

The preliminary objective of this project will be to develop an organic water quality analytical program so that background concentrations of dissolved and sediment organic materials can be determined and characterized for surface and ground water in regions of oil shale and coal development. The overall objective is to determine the capacity of spent oil shale residues to absorb and immobilize residual organic substances in retort waters.

11f(32) "Reconnaissance Techniques for Evaluation of Rehabilitation Potential of Energy Resource Lands"

The purpose of this project will be to refine and apply reconnaissance techniques that will provide mapable and other easily assimilated information to be used as baseline data to determine the potential for rehabilitation of land-water systems. The study effort was conducted by the Water Resources Division of the U.S. Geological Survey in 1974-75 at a cost of $130,819.

11f(33) "Assessment of Geothermal Resources of the U.S. - 1975"

This Geological Survey - Circular 726 was prepared in cooperation with the Energy Research and Development Administration. This assessment consists of two major parts: (1) estimates of total heat in the ground to a depth of ten kilometers and (2) estimates of the part of this total heat that is recoverable with present technology, regardless of price. Included in the report are all areas that are presently being utilized or explored for the generation of electricity.

11f(34) "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

11f(35) "Evaluation of Aquifers to Determine Water Quality Availability and the Possible Impacts from Energy Production in Southeastern Montana"

This project sponsored and conducted by the U.S. Geological Survey will provide basic data describing stream flows, quality of water, sediment load, and ground-water in the northern great plains coal region of Montana. This interpretive study is designed to collect and use base-line data to help predict the effects of activities on shallow aquifers. The project started on July 1, 1973 and is a continuing study. The project is currently funded at $750,000.

11f(36) "A Guide to State Programs for the Reclamation of Surface Mined Areas"

The U.S. Geological Survey has published in 1976, circular no. 731, which addresses state programs for reclamation in surface mined areas. In the report, each state is analyzed and their laws, regulations and requirements for reclamation have obvious implications towards water requirements. There is also an identification of the requirement by the state for controls over water flow and water quality.

11g. Water for Energy Management Team

11g(1) "Water for Energy in the Northern Great Plains Area with Emphasis on the Yellowstone River Basin"

This January, 1975 report has been prepared to serve as an important guideline for determining future policy on energy-water issues. The report focuses around six major areas: (1) legal parameters, (2) water supply, (3) present water uses, (4) future energy development and related water supplies, (5) other future water needs, (6) water management and distribution potentials. Section 4 of the report lists specific water requirements for coal processing and revegetation of mined lands.

11g(2) "Water for Energy in the Upper Colorado River Basin"

This publication completed July, 1974 treats five main topics: (1) legal parameters, (2) water supplies and uses, (3) future energy development and related water supplies, (4) other future water needs, and (5) augmentation and water management potentials. The third section of the report focuses on in-progress, planned and projected energy developments. These are identified by plant type and state, with corresponding water requirements given.

11g(3) "Study of the Social Impact of the Allocation of Large Portions of Water from the Yellowstone River Drainage to Coal Related Industrial Developments"

This project was designed primarily to encourage public dialogue on the questions of priorities, needs, and the potential impacts of water use for coal development during the 3-year moritorium on water allocation in the Yellowstone River Basin. Information was obtained on water use and a sampling of residents was made to determine their attitudes after which studies were conducted to determine the pressures that existed for changes in uses and the need for legislative reform. The study was conducted for the Office of Water Research and Technology by Montana State University. The study started on January 1, 1975 and was completed December 30, 1975 at a cost of $27,475.

12. INTERSTATE COMMERCE COMMISSION

12a. "Deveopment of Coal Resources in the Eastern Powder River Basin of Wyoming" (see Bureau of Land Management study 11b(1), page 11)

13. NATIONAL COMMISSION ON MATERIALS POLICY

13a. "Material Needs and the Environment Today and Tomorrow"

Chapter 8 of this June 1973 report discusses the critical relationships of water and materials policy. It first discusses water resources and then water use, including mineral industry, coal gasification, shale oil and steam electric power. The chapter concludes by discussing ways to make the nation's water policies and programs more responsive to the needs of the materials system.

14. NATIONAL SCIENCE FOUNDATION

14a. "Energy Research and Technology - Abstracts of NSF/RANN Research Reports, October 1970 to December 1974"

The National Science Foundation through the subdivision of Research Applied to National Needs (RANN) has identified 530 studies that were conducted between October 1970 and December 1974. These studies are generally categorized as follows: solar energy, geothermal energy, energy conservation and storage, energy systems, energy resources, and energy and fuel transportation. Water as an independent and necessary resource is not mentioned in the abstracts of most all of the study efforts. A few of the studies have been independently identified in this publication.

14b. "Modeling Problems and Problem Avoidance in Water Resources Management"

A paper was published in March of 1972 as a result of a research contract issued by NSF/RANN to Cornell Universities Energy Project. The report discusses how problems can be avoided by creating artificial market places to allocate the assimilated capacities of the receiving water most efficiently. The report also examines the extent to which other problems can be avoided if the government were to create and sell discharge rights that could then be freely traded in a "rights market."

14c. "The Influences of Steam Condenser Effluent on Freshwater Phytoplankton Dynamics"

This study was conducted and published in 1971 by Cornell Universities Energy Project. It is primarily concerned with the effect of waters from generating facilities on the fresh waters into which they may be discharged.

14d. "Energy Development in the Rocky Mountain Region: Goals and Concerns"

This document prepared through the support of the National Science Foundation was completed July 1975. It is divided into three major sections. Section I contains two proposed regional energy policy statements. One prepared by the National Resources Council in consultation with the Human Resources Council of the Federation of Rocky Mountain States and was drafted by the aides of the five Western Governors who direct the Federation of Rocky Mountain States. Also in Section I is an energy "Statement of Concern" issued by the ten western governors. Section II describes the Rocky Mountain West and the plan to identify specific energy production problems for the region and suggest possible actions to strike a balance between increased energy production and maintenance of the regions quality of life. This section further indicates the amounts of water used in the production of various energy sources and the water supply situation for river basins in the Rocky Mountain West. Section III is a compendium of background documents that supports statements made in Section II. The water problem receives special attention in Part 4 - Balancing Resource Use.

14e. "Western Water Needs for Energy Conversion and Processing with Environmental Quality Constraints"

Water Purification Associates has contracted to perform this study for the National Science Foundation. The research objective is to assess water needs of coal gasification and liquefaction, extraction of oil from shale and conversion systems for generating electric power within environmental constraints characteristic of the semi-arid western region of the United States. Overall project objectives include determination of the quantitative and qualitative demands on water for producing low btu clean gas from coal, high btu gas from coal, oil from coal, oil from shale, and steam-electric power. Determination will be made of those water treatment processes which are optimum for incorporation into the most promising energy conversion processes. The incremental costs of energy and environmental benefits if including water treatment will be evaluated as a function of site and conversion system. For each energy product, a number of processing methods will be selected and detailed calculations made for the quality and quantity of water required by and discharged from the process itself, waste water renovation and cooling requirements. Water treatment processes will be identified for potential use in processing of energy resources and to meet environmental quality standards. The project grant is for $191,200 and was to be completed January 31, 1976.

14f. "The Impact of Coal Development in the Fort Union Basin, Montana and Neighboring States"

The National Science Foundation Office of RANN has sponsored a study that will gather biophysical base line data that are needed for environmental assessment. These baseline studies will focus on hydrology. The study abstracts notes that Montana is well suited for studying the environmental effects of increased industrialization because the area is still in a nearly pristine state, hence, environmental assessments can be meaningful. The study is being conducted for the National Science Foundation by the University of Montana. The funding has been set at $175,000. The study was started on May 1, 1975 and is scheduled for completion on April 30, 1976.

15. NUCLEAR REGULATORY COMMISSION

15a. "Nuclear Energy Center Sites Survey"

This study concerns the feasibility and practicality of nuclear energy centers. A number of arbitrary sites were picked for the purposes of studying the issues and problems which an energy center might raise. The report specifically speaks of the water availability consisting mainly of water resources and of heat dissipation and waters role therein. A dry cooling site was also selected as a study area because it is the only probable type of energy center that could be located in the West. The study should be completed by June 30, 1976. Three reports in response to a Congressional mandate were submitted to Congress by the United States Nuclear Regulatory Commission in January of 1976. They were entitled, "Nuclear Energy Center Site Survey - 1975 (1) Summary and Conclusions (NUREG - 0001), (2) Executive Summary (NUREG - 0001-ES), and (3) United States Map - Coarse Screening Results (NUREG - 0001) The total cost of the study should be between $1.5 and $3 million.

16. SMITHSONIAN INSTITUTE

16a. "Computer File"

The Smithsonian Institute has a large computer storage program of energy related research projects. The institute provided the Western States Water Council with a voluminous and detailed print-out of many research efforts that the Institute felt might be of interest. Only a few of those identified studies were found by Council staff to be closely oriented with the topic of this report. The Smithsonian Institute is an excellent resource contact for those looking for total analysis of energy research projects.

16b. "Air and Water Conservation Related to Petroleum Processing and Use"

This project is a research and development project looking at processes and design options in proceeding to secure cleaner petroleum processing water effluent, cleaner petroleum processing effluent to the atmosphere, low sulfur fuels and reduction of automotive emissions. This study which was conducted by the Chevron Research Company spent an unspecified amount of funds in 1974 and 1975 on this project.

17. WATER RESOURCES COUNCIL

17a. "Purposes, Policy, Objectives"

The statement of Purposes, Policy and Objectives as related to energy and water was revised in April 1975 and is meant to guide the Council's development implementation of policies, programs, and activities in the future. The first objective is related to the water for energy portion of the "1975 Assessment of Water and Related Land Resources." This is a major study effort of the U.S. Water Resource Council and a special team worked on a revision of the "central-case scenario" of water-energy demands. A result of this effort is a numerical print-out giving potential water demands for various uses in regions of the United States.

The second objective deals with the Nuclear Regulatory Commission and the Council's assistance with their nuclear energy site assessment study. In the past, very little emphasis has been given to this objective, according to Arden O. Weiss of the Water Resources Council. He further mentioned that since the objectives are presently being reviewed and updated that this objective will be phased out.

Objective 3 deals with the U.S. Water Resources Council's role in Section 13 of the ERDA Act. Section 13 of the ERDA Act calls for potential Council input to the non-nuclear portion of research related assessments. The U.S. Water Resources Council could receive as much as $1 million from ERDA for this purpose. Late in the 1976 FY, it is only expected to receive about $300,000 to carry until July of 1976. Recently, a contract has been signed and consultants are being retained to help suggest future work programs.

Objective 4 of the U.S. Water Resources Council is to update the FEA Project Independence report. In the update version, the impact of the new energy policy and conservation act will be considered with reference to the effect it will have in obtaining the objectives set forth in the Project Independence report. Timing for release of the U.S. Water Resources Council's part of the report is February 1976.

17b. "Water for Energy Self-Sufficiency"

This continuing study started in 1974 and was undertaken to provide recommendations to the Executive Branch on a course of action with regard to meeting the energy related water needs of the Nation. It has resulted in a publication that accompanied the report to the President on Energy Self-Sufficiency. It describes general water availability by region, existing impediments and constraints to its use for energy, present energy related federal water programs and needed additions thereto. Information needed for the report was collected from states, federal agencies, and regional groups.

17c. "Executive Summary, National Conference on Water"

This Conference, held on April 22-24, 1975, focused on two primary objectives: (1) examination of the role of water in national affairs through 1985, and (2) consideration of the adequacy of existing and proposed policies and programs in fulfilling this role. Eight panels made formal presentations during the Conference, one of which directed itself to the topic, "Water and Energy." In addition to the panel participants statements, there was open discussion among the participants of each panel as well as opportunity for written and oral questions and brief statements from the floor.

17d. "Energy, Water and the West"

On November 3, 1975, Warren D. Fairchild, Director of the U.S. Water Resources Council, presented this statement to the National Conference of State Legislatures. His purpose in giving that statement was to discuss the issues and problems as seen by the Water Resources Council and to treat six basic topics. (1) water availability in the West and energy development, (2) present commitment of water resources v. supply, (3) is the problem one of allocation or scarcity? (4) setting priorities for water resource allocation, (5) implications of redistribution of water resources, and (6) need for water redistribution and program development.

17e. "Water Requirements, Availabilities, Constraints, and Recommended Federal Actions"
(see Federal Energy Administration study 9c, page 11)

MULTI-GOVERNMENTAL ORGANIZATIONS

18. BLACK HILLS CONSERVANCY SUB-DISTRICT

18a. "A Conceptual Study of a Missouri River - Wyoming Aqueduct"

This study is investigating four possible aqueduct routes that could provide water if needed to Western South Dakota to satisfy potential water needs brought about in part by accelerated energy resource development. The study is sponsored by the Black Hills Conservancy Sub-District and is a one-year study which was to be completed by December 31, 1975. The cost is $35,000.

19. COUNCIL OF STATE GOVERNMENTS

19a. "Council of State Governments Priority List of Policies and Procedures"

The Council of State Governments are, at present, working on a priority list of policies and procedures. Energy is a major concern as it is possible that the states role in the water issue may appear on that priority list.

20. FEDERATION OF ROCKY MOUNTAIN STATES

20a. "Coal in the Rocky Mountain Region"

This May 1974 report is a summary of coal resources and development within the states of Montana, Idaho, Wyoming, Utah, Colorado and New Mexico. It discusses coal resources in production, as well as potential resource development and federal leasing within these six Rocky Mountain States.

20b. "Rocky Mountain Region - A Unity of Interests"

This recently completed publication serves as a regional data book for the eight Rocky Mountain States and contains information on natural resources, land use, economy, politics and social issues. Tables show the estimated water use in the United States and the amount of water used for rural, irrigational and industrial purposes, hydroelectric power and electric utility generation.

20c. "Energy Development in the Rocky Mountain Region: Goals and Concerns" (see National Science Foundation study 14d, page 23)

21. FOUR CORNERS REGIONAL COMMISSION

21a. "Efforts of the Four Corners Regional Commission"

The Four Corners Regional Commission is not involved in any direct water for energy type studies. They are involved indirectly in that they have committed for the 1976 fiscal year, $160,836 to help finance the newly created Western Governors' Regional Energy Policy Office. Beyond this fiscal year, the Four Corners Regional Commission is not committed to any programs at the present time.

22. MISSOURI RIVER BASIN COMMISSION

22a. "Level B Study of the Yellowstone River Basin and Adjacent Coal Areas"

The proposal of this study was submitted in August 1974 and received approval in December 1975. The study involves the Yellowstone Basin and adjacent coal areas in the states of Montana, Wyoming, and North Dakota. It will be oriented towards evaluations of water and related land resources for the study area with the objective of aiding and resolving complex long-range problems emphasizing the needs of the period from 1985 to 2000. It will involve federal, state, and local interests in the plan formulation, identify alternative plans and recommend action to be pursued by individual federal, state and local agencies. At the present time, a detailed plan of study is being completed. Appropriate funds for the project are $1.1 million, not including the services of the states which will probably match that amount. The expected completion date of the project is between January and March of 1977.

23. NATIONAL CONFERENCE ON STATE LEGISLATURES

23a. "Energy, Water and the West"

This workshop held November 2-5, 1975 in Albuquerque, New Mexico was sponsored by the National Conference of State Legislatures for Western Legislatures. The proceedings of the workshop will be printed and should be available in February of 1976.

24. NATIONAL GOVERNORS' CONFERENCE

24a. "National Governors' Task Force on Water for Coal Energy"

This task force with special involvement of ten states, primarily in the West, is chaired by Governor Kneip of South Dakota. At present one meeting has been held, work plans are being formulated. Things that might be addressed are: How do you allocate a scarce resource such as water, what are some of the legal and institutional relationships and constraints, and what do we know about constraints involved with coal and other energy resources. Interstate relations may be examined.

24b. "Optimal Distribution of Energy Industries Relative to Limited Water Resources"

This project is funded by the National Governors Conference and is being performed for them by New Mexico State University's School of Engineering. New Mexico has a potential in the future as an energy exporting state . This study is intended to help unify New Mexico's energy policies by planning the management of water resources for an expanded energy industry. Funded in the 1975 fiscal year was reportedly at $38,726.

25. NORTHERN CHEYENNE RESEARCH PROJECT
(Northern Cheyenne Tribe)

25a. "Potential Impacts of Ground-water and Surface-water Quality and Quantity from Proposed Energy Development on the Northern Cheyenne Reservation, Montana"
(see Enviromental Protection Agency study 8k, page 9)

26. OLD WEST REGIONAL COMMISSION

26a. "Energy Computer Program"

The Old West Regional Commission has an ongoing, constantly updated energy information study that has been placed in a computer program. This is updated each month. Reports are printed quarterly and the 1st was released as Vol 1, No. 1, Nov 1975 and the 2nd was released as Vo11, No.2 Feb 1976. It lists the energy related research that is occurring in the states that are members of the Old West Regional Commission. Those states are: Montana, Wyoming, North Dakota, South Dakota and Nebraska. Information from this computer indexing can be obtained by writing the Old West Regional Commission in Billings, Montana. Some of the indexed material that seems to relate most directly to water for energy has been reported in this publication of the Western States Water Council and listed under the agency or agencies involved in the study effort.

26b. "Hydrologic Characteristics of Mine Spoils"

The Old West Regional Commission has sponsored a study that will be conducted by the Montana Bureau of Mines and Geology to gather data on water flow and chemistry of selected mine spoils. There will be developed, a model to simulate pre and post mining systems and to simulate and predict flow quantities and flow qualities so that alternative mining and reclamation techniques may be reliably evaluated. The study began on June 16, 1975 and is scheduled for completion on July 30, 1977. An estimated cost for the project is $97,400.

27. PACIFIC NORTHWEST REGIONAL COMMISSION

27a. "Northwest Energy Policy Project"

The Pacific Northwest Regional Commission officially launched this two-year $1 million project in November 1975. It will assess future regional energy demands, the impacts of meeting or modifying those demands, the consequences of failure to meet demands, opportunities for energy conservation, and other related matters that will assist the Northwest states, utilities, other energy suppliers, local governments and federal agencies in energy planning on a coordinated regional basis. A principle objective of the project is to identify policy levels that are susceptible to management by the governors and legislatures of the Pacific Northwest states to influence future patterns of energy consumption and energy production in the Northwest. As interim information is developed that might be useful to the Northwest states, it will be published in the form of interim reports so there will be no delay in making use of the project findings.

28. PACIFIC NORTHWEST RIVER BASIN COMMISSION

28a. "Comprehensive Coordinated Joint Plan for Land and Water Resources"

The purpose of this study is to bring together four years of commission studies and plannings. It will include Level B studies of water plans and energy developments in the Northwest region and will refer to the needs of water for energy. This four year study is to have a draft report available in April 1976 and the final publication by June 30, 1977.

28b. Punch card inventory

The Pacific Northwest River Basins Commission maintains an effective punch card inventory system of water and related resource studies of the region with more than 1600 entries included. This system is updated annually. Sufficient information is given on each card to allow the user to judge the value of any entry to his needs and tell him where he may obtain more complete information. The system is available to anyone at the nominal cost for quick-copying the desired entries. Information can be taken from the inventory from several viewpoints, including (1) geographical area, i.e., the region, state,county, drainage basin or individual stream. (2) organization conducting the study, (3) study purpose, (4) study status, either proposed, underway or completed, and (5) level of study, either reconnaissance, feasibility, design or as otherwise indicated.

28c. "It's Everyones' River"

This is a transcript of proceedings of a one-day workshop on the Columbia River. A great deal of information on the compatible and conflicting uses of water are presented on such subjects as power (hydro and thermal), flood control, irrigation, fish and wildlife, commerce and navigation, Indian view points and scenic and recreation.

28d. "Sources of information on Nuclear Power and the Environment"

This publication is a revision of a 1973 printing and is a product of the Pacific Northwest River Basins Commission's Power Planning Committee. This edition reflects the restructuring that has taken place in the Federal Regulatory Authority and also some important developments and side evaluation procedures of various states. It further includes references to a number of the most recent publications on nuclear power and the environment.

29. WESTERN GOVERNORS' REGIONAL ENERGY POLICY OFFICE

29a. "Western Governors' Regional Energy Policy Office"

The Western Governors' Regional Energy Policy Office acts as an analysis agency. They analyze actions of the federal government and how it affects the states. This newly created organization is a multi-state organization created by 10 Governors. Their offices are in Denver, Colorado and the staff lead is William L. Guy, former governor of North Dakota. It is felt that in the future the office may address water issues as they relate to energy policy.

29b. "Public Policy Resolution 75-13"

This resolution by the Western Governors' Regional Energy Policy Office urges caution in with-

drawal of western water. It resolves that long-term impact of water withdrawal should be studied and opposes the proposal that the slurry pipeline be given eminent domain.

29c. "Efforts of the Four Corners Regional Commission"
(see Four Corners Regional Commission study 21a, page 26)

30. WESTERN INTERSTATE NUCLEAR BOARD

30a. "Western Energy Resource Developments - 1976"

This report will be an update from the 1972 publication, "Energy Resource Development in the West." New data available from federal agencies will be used to recalculate energy consumption and production data for each state in the West. A 1974 report was the basic energy document used by the Western States Water Council in the preparation of "Western States Water Requirements for Energy Development to 1990." Anticipated growth projection of thermal electric generation in the West will be included in the second report. WINB does not anticipate including any predictions on the water needs. Anticipated printing date is June 1976.

31. WESTERN STATES WATER COUNCIL

31a. "Western States Water Requirements for Energy Development to 1990"

This report was prepared to help the Western States assess the potential demands for water related to the development of western energy resources to the year 1990. The study is limited to the water needed for energy resource development in the eleven Western States, namely, Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington and Wyoming.

32. YELLOWSTONE-TONGUE AREA PLANNING OFFICE

32a. "Yellowstone-Tongue Water Quality Management Project"
(see Environmental Protection Agency study 8b, page 8)

33. COLORADO DIVISION OF WATER RESOURCES

33a. "Quarterly reports on the development of a water data bank"
(see Federal Energy Administration study 9d, page 11)

34. MONTANA BUREAU OF MINES AND GEOLOGY

34a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana"

This three-year study provides for a monitoring system and pumping tests as well as chemical analysis to determine the quantity and quality of water in mined areas. The study is to be completed on June 30, 1976 with cost estimated at $90,000. The Montana Bureau of Mines and Geology is a participating agency with Montana State University and Montana University Joint Water Resources Research Center. Montana Bureau of Mines and Geology is involved in several studies not independently listed in this publication including "Pre-Mining Hydrologic Evaluations North and East of Decker, Montana," "Hydrology of Western Energy Company's Probable Mine Areas," "Shallow Ground-Water Study Related to Coal in Specified Areas of the Powder River Basin, Montana and Wyoming," "Evaluation of Aquifers Associated with Potential Coal Development, Southeastern Montana," "Mining-Related Hydrologic Evaluations Near the Big Sky Mine, Southeastern Montana," "Pre-Mining Hydrologic Evaluations in the Southern Part of the Crow Indian Reservation, Southeastern Montana," "Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana," "Hydrologic Investigations at Colstrip, Montana," "Ground-Water Problems Associated with Potential Strip Mine Sites," and "Hydrologic Characteristics of Mine Spoils." The previous listings indicate only some of the studies now being conducted by the Montana Bureau of Mines and Geology with respect to energy. The studies listed are intended to focus the reader on studies that relate to water resources. The studies listed have a combined budget of $319,222 and have as additional partially sponsoring participants, Decker Coal Company, Western Energy Company, Northern Great Plains Resources Program, Environmental Protection Agency, U.S. Geological Survey, Peabody Coal Company and Shell Oil Company.

PRIVATE ORGANIZATIONS

35. AMERICAN WATER RESOURCES ASSOCIATION

35a. "Water for Oil Shale"

This article from the October 1975 Water Resources Bulletin looks at water intensive energy development in an arid rural area. The region considered is mainly the State of Colorado. The first section deals with the region itself, its resources and water supply capability and the projected impacts of a fully developed oil shale industry on the water resource. The final section presents several examples of institutional allocation mechanisms that may suggest a conceptual range of approaches to resource allocation problems.

36. BATTELLE NORTHWEST

36a. "Northwest Regional Assessment of Energy Resources Including Water Resources in Coal Fields of Wyoming and Montana" (see Energy Research and Development Administration study 6d, page 6)

36b. "Assessment of Requirements for Dry Towers" (see Energy Research and Development Administration study 6e, page 7)

37. BECHTEL INC.

37a. "Slurry Pipelines - Energy Movers of the Future"

This paper was prepared for presentation at the Inter-Pipe '73 Conference in Houston, Texas. The efficiency and importance of the slurry pipeline in helping to solve the nation's energy crisis are the major topics of the paper. It summarizes the "limited" energy alternatives of the future (natural gas, nuclear power, crude oil, coal). Water requirements expressed in gallons per million btu delivered are given for extract slurry, coal slurry, and coal gasification processes.

37b. "Economics of Slurry Pipeline Systems"

This paper presented at Hydro Transport III- Colorado School of Mines in May 1974 discusses the economics of transportation of solids in slurry pipeline systems. Costs of alternate form of transportation are also discussed. Energy and water requirements of commercial slurry pipeline transportation systems are given.

37c. "Coal Transportation Economics"

This May 1974 paper explores two basic areas (1) the economics of slurry pipeline and rail delivering western coal to mid-west markets and, (2) siting alternatives of coal conversion plants. Water requirements and water availability receive some attention in the paper.

37d. "Slurry Pipeline Systems for Coal, Other Solids Come of Age"

This article from the Oil and Gas Journal printed July 21, 1975, treats the technical feasibility and economic advantages of slurry pipelines. A brief analysis of water requirements for the pipeline is given.

38. BECK, R.W., AND ASSOCIATES

38a. "Economics of the Use of Surface Condensers with Dry-Type Cooling Systems for Fossil-Fueled and Nuclear Generating Plants" (see Atomic Energy Commission study 3b, page 3)

39. CATALYTIC, INCORPORATED

39a. "Study of Dry-Type Cooling Towers and Their Application to Large Nuclear Power Plants" (see Energy Research and Development Administration study 6c, page 6)

40. CONSERVATION FOUNDATION

40a. "The Southwest Energy Complex - A Policy Evaluation"

This case history is intended to highlight the policy conflicts arising in the Southwest and to investigate the ways in which the federal government helped cause them. Measures are suggested that might improve the chances from more enlightened federal policies in the future. The environmental issues raised by the southwest coal development are: air pollution from power plants, strip mining of coal, heavy water demands from the Colorado River, and aesthetic degradation. The discussion on water supply shows which states take how much water and in some cases, implies how much they will take in the future.

41. DECKER COAL COMPANY

41a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

41b. "Limnology of the Tongue River Reservoir: Existing and Potential Effects of Coal Strip Mining"

The Decker Coal Company is presently operating a large open-pit mine adjacent to and upstream from the Tongue River Reservoir. Periodic discharges from a settling pond, used to receive seep water pumped from the mine, enters the reservoir. Two additional mines are scheduled in the area. Nothing is presently known of the limnology of the reservoir or the potential impacts of the surface mining operation. Montana State University is conducting the study sponsored by the Decker Coal Company that will extend from April 1, 1975 to June 30, 1979. The cost of the study will be $58,260.

42. ELECTRIC POWER RESEARCH INSTITUTE

42a. "Water Supply - Data Base for Evaluation of Research and Development Programs"

This project will provide EPRI with an updateable and user oriented data base which contains relevant, available information on water supply and use. Included, will be data which describe water availability and characteristics and present the past consumptive use of selected water in the United States and selected projections of future use. Submittals were due December 31, 1975 so the project is just now getting underway. The cost of the project was not to exceed $150,000 with the final report being completed on or about February 1, 1977.

42b. "Dry-Cooling Towers in Water Scarce Areas"

EPRI has contracted General Electric in this two-fold effort to (1) evaluate how much demand there will be for energy growth in truly water scarce areas out to the year 2000, (2) to determine how the needs of those power plants can best be met. This may require alternatives such as dry-cooling, evaporative cooling, etc.

43. ENERGY AND MAN'S ENVIRONMENT, INC.

43a. "Conversion of Energy"

Energy and Man's Environment is an education organization providing curriculum supplements to schools in several Western States. This particular supplement takes on a type of workbook form with a concept presented, followed by a lesson objective with several activities. Using a simple format, the reader quickly becomes aware of many of the problems involved when we talk about energy and how to develop it. The concepts are: (1) energy conversion systems are subject to natural laws, (2) all conversion processes burn energy, (3) direct energy use is more efficient than converted energy use, (4) converted energy is more versatile than direct energy, (5) energy costs are related to the efficiency, (6) many benefits and problems are associated with energy conversion, (7) energy conversion technology creates technological and industrial changes, (8) history can be described in terms of the level of energy conversion technology, and (9) employment opportunities depend on the evolution of conversion technologies.

44. ENERGY TRANSPORTATION SYSTEMS, INC.

44a. "Slurry Pipelines -- Innovation in Energy Transportation"

This report prepared in May 1975 describes in simple terms, what slurry pipelines are and why we should have them. Existing and future pipelines are named. Coal slurry technology, consumer benefits, environmental benefits and water supply are discussed by a question and answer technique. It includes articles about coal slurry pipelines v. railroads; part of the testimony submitted to the House Committee on Interior and Insular Affairs; an article discussing the cost of coal transportation and an article on Congress is included in the report. Water requirements for the slurry pipeline are stated. The quantity and source of water to be used receive additional comment.

44b. "Progress With Coal Slurry Pipelines"

This paper was presented at the American Mining Congress, 1975 Mining Convention, in San Francisco, California. It shows how coal pipelines are an economical and environmentally beneficial method of expanding the nations' energy transportation system, particularly in handling the western coal. The energy capabilities and water requirements of slurry pipelines are included in the paper.

45. THE ENVIRONMENTAL POLICY CENTER

45a. " Water for Industry in the Upper Missouri River Basin"

The Environmental Policy Center, a non-profit environmental lobbying group headquartered in Washington, D. C. has released a report entitled, "Water for Industry in the Upper Missouri River Basin." The report concerns itself with instream and agricultural needs of the Northern Great Plains Region with respect to water resources and the potential impact that upstream energy development could have on these existing water needs and uses.

46. FRANKLIN INSTITUTE RESEARCH LABORATORIES OF PHILADELPHIA

46a. "Atomized Water Injection to Improve Dry Cooling Tower Performance" (see Energy Research and Development Administration study 6b, page 6)

47. GENERAL ELECTRIC

47a. "Dry-Cooling Towers in Water Scarce Areas" (see Electric Power Research Institute study 42b, page 32)

48. MONTANA POWER

48a. "Water Resources of the Yellowstone River"

Montana Power Company has been involved in investigations to determine the effect on the Yellowstone River of diversions for power purposes. A one-year study ended in 1973 that examined the ecological impact of potential diversions out of the Yellowstone River at Nichols. On January 1, 1976, a study was completed to examine 25 water quality parameters in Rosebud Creek, a tributary to the Yellowstone.

49. NATIONAL PETROLEUM COUNCIL

49a. "U. S. Energy Outlook - Water Availability"

This chapter of a December 1972 report looks at both the physical and legal constraints of supplying sufficient water for energy production. A detailed analysis of the Western States water requirements was made. The Eastern States were also considered, however, no detailed analysis was attempted. Where water availability proved to be a limitation on energy production, such limitations were identified and alternatives were examined.

50. NATIONAL RESOURCES ECOLOGY LABORATORY

50a. "Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development"
(see Environmental Protection Agency study 8m, page 9)

51. NORTH CENTRAL POWER STUDY COORDINATING COMMISSION

51a. "North Central Power Study - Vol. I and II"

To gather information for this October 1971 report, a water supply task force was organized. Its purpose was to explore water resources availability, location and quality. The study of water resources availability encompassed plans for delivery of water to twenty coal fields in Montana, two in North Dakota, one in South Dakota, six in Wyoming, and one in Colorado. Water requirements were also estimated for thermal generation plants.

52. NORTHERN GREAT PLAINS RESOURCES PROGRAM

52a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

53. PACIFIC POWER AND LIGHT

53a. "Dry Cooling Design Characteristics of a Large Power Plant"

This paper was presented at the 1975 Power Conference in Chicago, Illinois and deals with the Wyodak Power Plant in Wyoming which is equipped with a dry-cooling tower rated for 330 megawatts. This demonstration can signal the feasibility of this type of dry-cooling system when used in connection with high-backed pressure turbines. The plant is not expected to be able to demonstrate the utility of the dry-tower until 1978.

54. PEABODY COAL COMPANY

54a. "Effects of Coal Strip Mining on Vegetation and Soil Water Relationships"

Soil water flow is being studied and modeled in mined areas and in native range areas. The study is sponsored by Peabody Coal Company and is being conducted by Montana State University, Agricultural Experiment Station. The $20,000 study started July 1, 1975 and is expected to be completed July 1, 1976.

54b. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

54c. "Mining and Related Hydrologic Evaluations Near the Big Sky Mine, Southeastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

55. RADIUM CORPORATION

55a. " Power Plant Water Reuse and Waste Treatment" (see Environmental Protection Agency study 8e, page 8)

55b. "Western Energy Resource Development" (see Environmental Protection Agency study 8f, page 8)

56. SHELL OIL COMPANY

56a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

56b. "Pre-Mining Hydrologic Evaluations in the Southern Part of the Crow Indian Reservation, Southeastern Montana (see Montana Bureau of Mines and Geology study 34a, page 30)

57. STANDARD OIL COMPANY OF CALIFORNIA

57a. "Air and Water Conservation Related to Petroleum Processing and Use" (see Smithsonian Institute study 16b, page 24)

58. UNITED ENGINEERS INCORPORATED

58a. "Heat Sink Design and Cost Study for Fossil and Nuclear Power Plants" (see Atomic Energy Commission study 3a, page 3)

58b. "Optimizing Wet-Dry Cooling Towers for Water Conservation and Plume Abatement" (see Environmental Protection Agency study 8a, page 7)

59. WATER PURIFICATION ASSOCIATES

59a. "Western Water Supply Okay"

This article written by Water Purification Associates and printed in Chemical Engineering, May 12, 1975, discusses the idea that water requirements for coal gasification and liquefaction plants are less than half of what the energy planners have been estimating. The total water requirements for coal and oil shale conversion are discussed as well as the water supply in the Northern Great Plains.

59b. "Water Needs for Fuel to Fuel Conversion Processes"

This is a paper presented at a symposium on "Water Management for Energy Intensive Industries" on December 3, 1974. It summarizes some results obtained on the identification of the effluent and affluent water streams for the major fuel-to-fuel conversion processes, including the production of pipeline and power gas from coal, oil from shale, and oil from coal by hydrogenation. Emphasis is placed on the process stream requirements. Estimates are also given on water evaporated for cooling and cooling tower blowdown. The water requirements associated with mining, raw fuel preparation, spent fuel disposal, and land reclamation are presented only briefly as lumped estimates of a few are exemplary cases.

59c. "Water Requirements for an Integrated SNG Plant and Mine Operation"

This is a paper delivered at the second symposium on environmental aspects of fuel conservation technology sponsored by the U. S. Environmental Protection Agency in Hollywood, Florida, December 15-18, 1975 In this paper, details of the procedures for determining water requirements are given. The determination of the cost of not evaporating water for cooling, but of using air cooling and condensing is also described. It is shown that water requirements are dependent on process design, mine location and climate in the generalized assessments which are not site specific and design specific but are of limited value. It is also shown that the published water requirements for integrated SNG plants and mine operations in the West may be high and that the actual requirements could, depending upon location, be half the lowest estimate today.

59d. "Water Conservation and Pollution Control Alternatives in Coal Gasification and Liquefaction Processes" (see Environmental Protection Agency study 8h, page 9)

59e. "Western Water Needs for Energy Conversion and Processing with Environmental Quality Constraints" (see National Science Foundation study 14e, page 23)

59f. "Nuclear Power Plant Cooling Water Treatment" (see Energy Research and Development Administration study 6f, page 7)

60. WESTERN ENERGY COMPANY

60a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

60b. "Hydrologic Investigations at Colstrip, Montana" (see Montana Bureau of Mines and Geology study 34a, page 30)

61. WESTERN SYSTEMS COORDINATING COUNCIL

61a. "Power Generation in the Pacific Southwest"

This paper was presented to the Colorado River Water Users Association on November 19, 1974. The report discusses the creation of the Western Systems Coordinating Council and its responsibilities. It further lists the major coal fueled power plants together with information as to their total capacity, the number and size of units, the division of ownership and the sources of coal and cooling water. A discussion is also given on the various power plant cooling systems in use today.

The Western Systems Coordinating Council is a voluntary organization with offices and staff located in Salt Lake City, Utah. It is supported by the major utility companies in thirteen western states which include all of the eleven western states that are members of the Western States Water Council. The Western Systems Coordinating Council is not currently involved in any study efforts that directly analyze the need for water for energy resource development. However, this organization is an excellent source for information as to the projected demands as they work in close harmony with all of the major power companies to determine the plants that will be built, where they will be located, and the time in which the plants will be constructed and brought into production.

62. COLORADO SCHOOL OF MINES

62a. "Economics of Slurry Pipeline Systems" (see Bechtel Incorporated study 37b, page 31)

62b. "Water Prospects for the Emerging Oil Shale Industry"

This paper was presented by Felix L. Sparks before the Seventh Oil Shale Symposium, Colorado School of Mines, April 18, 1974. This paper discusses some of the problems involved in determining the availability of water when the extent of the oil shale production is not known. It also lists three courses of action that can be taken to secure water for the oil shale industry. The paper further includes a discussion of water quality as related to the oil shale industry.

62c. "Minerology of Overburden as Related to Ground-water Degradation in the Strip Mining of Coal" (See Environmental Protection Agency Study 8c, page 8)

63. COLORADO STATE UNIVERSITY

63a. "Quarterly Reports on the Development of a Water Data Bank" (see Federal Energy Administration study 9d, page 11)

63b. "Coordinating Water Management and Energy Development Strategies in the Upper Colorado River Basin"
(see Interior, Office of Water Research and Technology study 11e(9), page 16)

64. CORNELL UNIVERSITY

64a. "Energy Demand and Water Resource Management - The Economic Aspects"
(see Interior, Office of Water Research & Technology study 11e(7) page16)

64b. "Modeling Problems and Problem Avoidance in Water Resources Management"
(see National Science Foundation study 14b, page 22)

64c. "The Influences of Steam Condenser Effluent on Freshwater Phytoplankton Dynamics" (See National Science Foundation study 14c, page 22)

65. GEORGETOWN UNIVERSITY

65a. "Understanding the National Energy Dilemma - update"

All the homework for this 'update' of the 1973 report has been done. In 1973 a report was done by Georgetown University and is referred to in this report by the entry following this paragraph. However, the report will be completed and published only when and if the funding is available from an appropriate source. Further information may be received by writing to The Center of Strategic International Studies, Georgetown University, 1800 K Street, N. W., Washington, D.C. 20006.

65b. "Understanding the National Energy Dilemma" (see Congress study 4h, page 4)

65c. "Optimizing Wet-Dry Cooling Towers for Water Conservation and Plume Abatement" (see Environmental Protection Agency study 8a, page 7)

66. MONTANA COLLEGE OF MINERAL SCIENCE & TECHNOLOGY

66a. "A Cooperative Program to Evaluate Surface and Ground-water Problems Associated with Potential Strip Mine Sites"
(see Environmental Protection Agency study 8o, page 10)

67. MONTANA STATE UNIVERSITY

67a. "Effects of Surface Configuration in Water Pollution Control on Semi-Arid Mines Lands"
(See Environmental Protection Agency study 8d, page 8)

67b. "Geothermal Reconnaissance of Southwestern Montana"
(see Interior, U.S. Geological Survey study 11f(20), page 19)

67c. "Estimation of Amenity Values as Opportunity Costs for Energy-Related Water Use in Montana"
(see Interior, Office of Water Research and Technology study 11e(4), page 15)

67d. "Coal Energy Development in the Northern Great Plains"
(see Interior, Office of Research and Technology study 11e(11), page 16)

67e. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana"
(see Montana Bureau of Mines and Geology study 34a, page 30)

67f. "Effects of Coal Strip Mining on Vegetation and Soil Water Relationships"
(see Peabody Coal Company study 54a, page 34)

67g. "Effects of Surface Mine Configuration on Water Pollution Control on Semi-Arid Mines Lands"
(see Environmental Protection Agency study 8n, page 10)

67h. "A Cooperative Program to Evaluate Surface and Ground-water Problems Associated with Potential Strip Mine Sites"
(see Environmental Protection Agency study 8o, Page 10)

67i. "Estimation of Amenity Values as Opportunity Costs for Energy - Related Uses in Montana"
(see Office of Water Research & Technology study 11e(4), page 15)

67j. "Limnology of the Tongue River Reservoir: Existing and Potential Effects of Coal Strip Mining"
(see Decker Coal Company study 41b, page 32)

68. MONTANA UNIVERSITY JOINT WATER RESOURCES RESEARCH CENTER

68a. "Study of Possible Effects of Strip Coal Mining on the Hydrologic System in Eastern Montana"
(see Montana Bureau of Mines and Geology study 34a, page 30)

69. NEW MEXICO STATE UNIVERSITY

69a. "Use of Brackish Water for Coal Gasification"
(see Interior, Office of Research & Technology study 11e(6), page 15)

69b. "Optimal Distribution of Energy Industries Relative to Limited Water Resources"
(see National Governors' Conference study 24b, page 27)

70. NORTH DAKOTA UNIVERSITY

70a. "Coal Energy Development in the Northern Great Plains"
(see Interior, Office of Research & Technology study 11e(11), page 16)

70b. "A Cooperative Program to Evaluate Surface and Ground-water Problems Associated with Potential Strip Mine Sites"
(see Environmental Protection Agency study 8o, page 10)

71. OREGON STATE UNIVERSITY

71a. "Proceedings from Conference on Magnitude and Deployment Schedule of Energy Resources"

This three-day conference was held in July, 1975, at Portland, Oregon. A copy of the proceedings may be obtained from the Office of Energy Research and Development, Oregon State University, Corvalis, Oregon.

72. UNIVERSITY OF ARIZONA

72a. "Surface Mining and Water Resources in the Southwest"
(see Interior, Bureau of Mines study 11c(2), page 12)

72b. "Computer Indexing"

The University of Arizona has a computer file that is updated periodically that tabulates ongoing study efforts relating to energy. Some of these study efforts are in the water for energy area. Therefore, a print-out at any point in time from their computer files could be helpful to individuals looking for information with respect to ongoing studies that relate to water for energy in Arizona and in the western United States.

73. UNIVERSITY OF ARKANSAS

73a. "Water Resources Aspects of Coal Transportation by Slurry Pipeline"
(see Interior, Office of Water Research & Technology study 11e(1), page 15)

74. UNIVERSITY OF CALIFORNIA

74a. "Energy Requirements of Environmentally Influenced Decisions Involving Water Development and Use"
(see Agriculture Department study 2b, page 3)

75. UNIVERSITY OF ILLINOIS

75a. "The Importance of Energy-Related Water Demands in Developing Regional Water Resources - an Optimization Approach"
(see Interior, Office of Water Research & Technology study 11e(5), page 15)

76. UNIVERSITY OF IOWA

76a. "Optimization of Water Consumption and Cost of Cooling Towers for Power Plants by use of Combination Dry-Wet Towers"
(see Interior, Office of Water Research & Technology study 11e(2), page 15)

77. UNIVERSITY OF MONTANA

77a. "Water Use and Coal Development in Eastern Montana"

The purpose of this 1974 study was to determine the economic implication of coal related development in Eastern Montana. The report was prepared by the Bureau of Business and Economic Research at the University of Montana. The study considers questions such as; how many jobs will be created; will the

population mushroom; will living conditions be better; what will be the effect on construction activity; how will coal related development affect agriculture; how will coal related development affect water use? Additional water requirements are estimated and methods of obtaining the needed water are discussed briefly.

77b. "Surface Mining and Water Resources in the Southwest"
(see Interior, Bureau of Mines study 11c(2), page 12)

77c. "The Impact of Coal Development in the Fort Union Basin, Montana and Neighboring States"
(see National Science Foundation study, 14f page 23)

78. UNIVERSITY OF NORTH DAKOTA

78a. " A Cooperative Program to Evaluate Surface and Ground-water Problems Associated with Potential Strip Mine Sites"
(see Environmental Protection Agency study 8o , page 10)

79. UNIVERSITY OF WYOMING

79a. "Hydrology of Madison Formation and its Potential Use for Water Supply for Energy Development"
(see Interior, Office of Water Research & Technology study 11e(3), page 15)

79b. "Coal Energy Development in the Northern Great Plains"
(see Interior, Office of Water Research and Technology study 11e(11), page 16)

79c. "A Cooperative Program to Evaluate Surface and Ground-water Problems Associated With Potential Strip Mine Sites"
(see Environmental Protection Agency study 8o, page 10)

80. UTAH STATE UNIVERSITY RESEARCH CENTER

80a. "Impacts on Agricultural Land Use, Income, and Employment Resulting From Water Transfers to Facilitate Oil Shale Development"
(see Interior, Office of Water Research & Technology study 11e(8), page 16)

INDIVIDUAL SUMMARY REPORTS FROM THE ELEVEN WESTERN STATES AS MEMBERS OF THE WESTERN STATES WATER COUNCIL

81. ARIZONA

The two major electrical utilities in Arizona have filed commitments to purchase 592,000 acre-feet of Central Arizona Project water to meet future cooling requirements. As total commitments from municipalities and industries in central Arizona for M&I service exceed the supply available for that purpose by a factor of almost five to one the State is faced with the difficult problem of deciding how to allocate the limited resources amongst the competing needs of the cities, electrical utilities and the mines. The Arizona Water Commission is currently considering this problem but had not reached a decision on how this will be done at the time that this was written.

The electrical utilities have entered into a long-term contract with the City of Phoenix on municipal effluent to serve as water supply for the first nuclear plant to be built in Arizona. The State looks with favor upon this use of effluent and means of meeting the needs of the electrical industry.

The new coal fired plant being built by the Salt River Project near St. Johns will utilize groundwaters too saline for municipal and agricultural purposes. This is another approach favored by the State as there are large amounts of brackish groundwater in Arizona. The potential for meeting future needs for power development in this manner is very real and will be seriously considered in the future.

In areas of the State where energy development is necessary and alternative sources are not available, water requirements for energy development will undoubtedly be met as they have in the past through the purchase and retirement of agricultural water rights. The State has not taken action to prevent such transfers and it seems highly unlikely that it will do so in the foreseeable future.

82. CALIFORNIA

The California Water Code in Sections 237 and 462 directs the Department of Water Resources to:

> 237. "...either independently or in cooperation with any person or any county, state, federal, or other agency, including, but not limited to, the State Energy Resources Conservation and Development Commission, shall conduct studies and investigations on the need and availability of water for thermal electric powerplant cooling purposes, and shall report thereon to the Legislature from time to time...."
>
> 462. "...conduct studies and investigations on the availability and quality of waste water and uses of reclaimed waste water for beneficial purposes including, but not limited to...cooling for thermal electric powerplants."

As described below, cooling water supplies have been identified for all inland thermal electric powerplants currently under consideration for near-future construction. The Department therefore has deferred studies of the availability of water for cooling purposes except for the research work being conducted on agricultural waste water.

Potential future inland thermal electric power plants in California requiring cooling water include Sacramento Municipal Utility District's Rancho Seco No. 2, Los Angeles Department of Water and Power's San Joaquin Nuclear Project (Wasco), and plants in the eastern Mojave Desert area.

The Sacramento Municipal Utility District has contracted with the U.S. Bureau of Reclamation for high-quality American River water out of Folsom Reservoir. Cooling water for Rancho Seco No. 1 is being delivered through a recently completed reach of the Folsom South Canal.

Metropolitan Water District of Southern California (MWD) has approved in principle an allocation of 60,000 acre-feet per year of its State Water Project water from the California Aqueduct for cooling purposes at the San Joaquin Nuclear Project. The Letter of Intent is between MWD and the Los Angeles

Department of Water and Power (LADWP) and recognizes that agricultural waste water should be used for power plant cooling to the extent practicable. The Department of Water Resources must also approve the delivery of water outside the MWD service area.

The MWD has also approved in principle the allocation of 100,000 acre-feet per year of Colorado River water for power plant cooling and related purposes in the eastern Mojave Desert area. Forty thousand acre-feet per year of this water was allocated in 1973 to Southern California Edison Company for its proposed high desert nuclear plant (Vidal). In 1974, Letters of Intent were approved in principle for the allocation of the remaining annual quantity of 60,000 acre-feet as follows: an additional 10,000 acre-feet each year to Edison; 33,000 acre-feet per year to LADWP; and 17,000 acre-feet per year to San Diego Gas and Electric Company (SDG&E).

In keeping with state policy and concern for the most efficient use of available water supplies, the Department of Water Resources is currently investigating the feasibility of treating agricultural waste water for power plant cooling. Studies are being conducted in cooperation with Los Angeles Department of Water and Power, Pacific Gas and Electric, Southern California Edison, and the Electric Power and Research Institute. The treatment process was developed in the laboratory by the University of California. A pilot plant will be tested by the Department at its Waste Water Treatment Evaluation Facility near Firebaugh, California. The development of a treatment process for using this water will assist in siting flexibility for power plants and in augmenting the water supplies of the State.

Agricultural drainage water will be used for cooling purposes at the Sundesert nuclear plant being proposed by San Diego Gas and Electric at a site near the Palo Verde Irrigation District. The District is located along the Colorado River south of Blythe.

The cooling water for the power plant will be obtained by diversions from the Palo Verde Outfall Drain, which collects irrigation drainage water from the Palo Verde Irrigation District and returns it to the Colorado River. All of the rights for the use of the available water from the Colorado River in California (including the water returned to the River by the Palo Verde Outfall Drain) have been completely allocated, so that no water supply is available for this project without the proposed agreements with MWD. Accordingly, an agreement is to be entered into under which SDG&E will purchase and consume up to 17,000 acre-feet per year of Colorado River water from MWD for cooling the initial generating unit of the project (and for a portion of the commingled supply required when the second unit is installed). MWD will make an offsetting reduction in the amount of water it diverts for conveyance to its service area (So.Cal.coastal area).

In addition, the SDG&E has purchased some 7,700 gross acres of land in the Palo Verde Irrigation District and, to the extent additional cooling water is needed, it will allow land to lie fallow on a rotational basis. Water from the Palo Verde Outfall Drain, equal to the reduction in net use accompanying such reduction in irrigation on the SDG&E's lands, would be utilized for powerplant cooling purposes.

By using the relatively highly mineralized agricultural waste waters from the Palo Verde Outfall Drain as the source of water for the powerplant and by allowing equal quantities of better quality Colorado River water to remain in the River in substitution therefor, there will be a beneficial reduction in the salinity of the water flowing in the Colorado River below the Palo Verde Irrigation District.

In June 1975, the State adopted a water quality control policy on the use and disposal of inland waters used for powerplant cooling. In administering the policy with respect to water use, the State Water Resources Control Board (SWRCB) will be guided by the following principles.

> It is the Board's position that from a water quantity and quality standpoint, the source of powerplant cooling water should come from the following sources in this order of priority depending on site specifics such as environmental, technical and economic feasibility consideration: (1) waste water being discharged to the ocean, (2) ocean, (3) brackish water from natural sources or irrigation return flow, (4) inland waste waters of low TDS, and (5) other inland waters.
>
> Where the Board has jurisdiction, use of fresh inland waters for powerplant cooling will be approved by the Board only when it is demonstrated that the use of other water supply sources or other methods of cooling would be environmentally undesirable or economically unsound.

In considering issuance of a permit or license to appropriate water for powerplant cooling, the Board will consider the reasonableness of the proposed water use when compared with other present and future needs for the water source and when viewed in the context of alternative water sources that could be used for the purpose. The Board will give great weight to the results of studies made pursuant to the Warren-Alquist State Energy Resources Conservation and Development Act and carefully evaluate studies by the Department of Water Resources made pursuant to Section 237 and 462, Division 1 of the California Water Code.

Studies of availability of inland waters for use in power plant cooling facilities to be constructed in Central Valley Basins, the South Coastal Basins or other areas which receive supplemental water from Central Valley streams as for all major new uses must include an analysis of the impact of such use on Delta outflow and Delta water quality objectives. The studies associated with powerplants should include an analysis of the cost and water use associated with the use of alternative cooling facilities employing dry, or wet/dry modes of operation.

The State Board encourages water supply agencies and power generating utilities and agencies to study the feasibility of using waste water for powerplant cooling. The State Board encourages the use of waste water for powerplant cooling where it is appropriate. Furthermore, Section 25601(d) of the Warren-Alquist Energy Resources Conservation and Development Act directs the Commission to study "expanded use of waste water as cooling water and other advances in powerplant cooling" and Section 462 of the Waste Water Reuse Law directs the Department of Water Resources to "...conduct studies and investigations on the availability and quality of waste water and uses of reclaimed waste water for beneficial purposes including, but not limited to...and cooling for thermal electric power plants."

Applications to appropriate inland waters for powerplant cooling purpose must include results of studies comparing the environmental impact of alternative inland sites as well as alternative water supplies and cooling facilities. Studies of alternative coastal sites must be included in the environmental impact report.

83. COLORADO

State effort is being made on determining water for energy primarily through federal grants from the U.S. Geological Survey and the Federal Energy Administration and through close cooperation with private enterprise engaged in developing oil shale and coal.

A grant from the U.S. Geological Survey is providing the funding to establish the situation on underground water in the Piceance Basin area in order to determine the effect, if any, of de-watering oil shale mining operations and putting this water to use in processing oil shale, reclaiming the land and providing for proper disposal of shale residue. A multitude of springs are being measured through the installation of Parshall flumes under the supervision of the State Engineer's Office.

Under a federal grant from the U.S. Geological Survey, the Colorado State Engineer's office is conducting a study of water supplies in the White River and the existing and potential uses of water in the White River Basin. Much of this work is being accomplished with photo imagery and ground checks.

The State Engineer's office is conducting a study of the decreed water rights in the Yampa River Basin as a part of a general water supply study contracted through CSU. Funding for this study is through the Federal Energy Administration.

A investigation is being conducted of potential geothermal energy development in the state funded by the Geological Survey and being conducted by staff of the State Engineer's office.

We are continuing to place records in the Water Data Bank concerning court decreed water rights, diversion records, etc., which will be of considerable advantage to consulting engineers, attorneys, private enterprise and the general public in conducting studies on water supply for energy and other purposes.

The Office of the State Engineer meets with the Rio Blanco Oil Shale Project staff periodically to coordinate the efforts of both in the field of developing water supplies for Tract Ca in the Piceance Basin.

The staff of the Division of Water Resources meets periodically with Houston Natural Gas Company and the Denver & Rio Grande Railroad to keep abreast of the developments on the proposed coal slurry lines from Walsenburg, Colorado, to Houston, Texas. It is felt that these meetings are mutually beneficial in keeping water officials of the state and the Department of Natural Resources advised and to assist the planners of this pipeline to file viable and acceptable applications for water rights.

84. IDAHO

In 1972, over 30 percent of electrical energy consumed in Idaho was supplied from outside sources. The available per capita consumption has continued to grow fairly fast within the state. Idaho has adopted as a planning objective the goal of reducing our reliance upon imported power to meet both present and future needs. Idaho recognizes the value of inter-ties, particularly to meet peak power needs and to utilize excess capacity during peak periods, but caution dictates that Idaho not become entirely dependent upon supplies over which we cannot exert control.

As part of the Idaho State Water Planning process, the Department of Water Resources has investigated energy needs as they relate to water resources and have identified these needs that will be necessary to support the level of development contemplated in the state's water plan. Based upon detailed studies, we have concluded that there is no water available in the areas south of the Salmon River for diversion to other basins, and in fact have concluded that there are not sufficient dependable water supplies within the Snake River Basin to meet our projected needs for our uses through the year 2020.

The State Water Plan for the Snake River Basin contemplates a moderate level of development which is restricted by water supply. Our projections for energy needs for the state indicates that by the year 2020 the state will need about an additional 10,000 megawatts of average capacity and will require over 200,000 acre-feet of water. The State Water Plan will allocate water specifically for future consumptive uses by thermal power plants by major stream reach. We have evaluated the potential for additional installation of existing hydro-power sites and have concluded that hydro-power cannot meet all additional demands. We have not included in the State Water Plan any wholely new hydro-power facilities not currently authorized upon our major streams, except to identify the potential for pump-back storage for meeting peak loads.

The Idaho Water Resource Board holds the water right for two projects, one of which has been approved for construction by the Legislature. The first, the Swan Falls-Guffey Project is the redevelopment of a current low head dam on the Snake River south of the city of Mountain Home by a two dam power complex. The complex would have a nameplate capacity of 160 megawatts. The other filing, called the Caribou project, in the Bear Lake Basin would be a low head dam and reservoir which would store approximately 50,000 acre-feet of water. Power facilities have not yet been sized. Other existing dams of which additional power facilities can be constructed appear to be American Falls Reservoir, Lucky Peak Reservoir, Brownlee Reservoir, Anderson Ranch Reservoir, and Minidoka Dam. Studies also have investigated the possibility of installation of additional power facilities at Palisades Reservoir in eastern Idaho. Reconnaissance level studies are being conducted for pump-back storage at Lake Lowell in Southwestern Idaho and at several locations in the central Snake River area in Southwestern Idaho. Similar studies have been conducted for areas within the Bear River Basin primarily around Bear Lake.

The state has also issued water right permits for cooling of the proposed Pioneer thermal coal-fired plant south of the city of Boise. That plant would be a 500 megawatt unit to come on line in 1981 and a second 500 megawatt unit to follow. Arthur D. Little has recently completed a study for Idaho Public Utilities Commission which estimated the additional capacity needed within the Idaho Power Service Area by 1990.

85. MONTANA

In March, 1974, the Montana Legislature enacted what has become known as the "Yellowstone Moratorium." This Act suspended action on pending applications for water use permits to Yellowstone River Basin waters in excess of 20 cubic feet per second or 14,000 acre-feet of storage. Effected by this action were applications requesting nearly a million acre-feet of water per year for energy production in Montana. In addition, the Act provided that the Department of Natural Resources and Conservation could apply for reservations of water and, as rapidly as possible, assist other appropriate state agencies and political subdivisions in applying for reservations within the basin; that particular emphasis be given to applications to reserve water for agricultural, municipal, and minimum flow purposes for the protection of existing rights and aquatic life; and that a reservation established prior to granting a permit on those suspended applications is a preferred use.

In response to the policy enunciated by the legislature, state water planning activities were concentrated on the Yellowstone Basin. The Missouri River Basin Commission was asked to seek funding for a Level B study of the Yellowstone River Basin and adjacent coal areas to be initiated in Fiscal Year 1975; a state planning team was formed to provide Montana's input to the Level B; and a proposal to study the impacts of water withdrawals and water development on the middle and lower portions of the Yellowstone River Drainage in Montana was submitted to the Old West Regional Commission for funding.

Although the Level B study was not funded until January, 1976, the state planning team has continued with its tasks, indentifying problems and issues within the basin, developing alternative solutions, making projections of future water requirements, and conducting a public involvement program. The state objective in both efforts is to develop a reconnaissance level plan for the Yellowstone Basin to be incorporated into the state water plan.

The study funded by the Old West Regional Commission will provide additional basic data to the planning efforts that would not otherwise be available. This study, now in its second year, is attempting to evaluate the potential physical, biological, and water use impacts of water withdrawals and water development on the middle and lower reaches of the Yellowstone River.

Based on an Environmental Impact Statement prepared by the Energy Planning Division under authority of the Major Facility Siting Act, the Department of Natural Resources and Conservation has recommended to its Board that a certificate of environmental compatibility and public need for Colstrip Units 3 & 4 be denied. A group of five private utilities including the Montana Power Co. had applied to add the two 700 MW coal-fired generating units to two 350 MW units (Colstrip Units 1 & 2) presently being completed. Upon completion of public hearings currently underway before the Board, the Board will determine whether or not to issue a certificate.

Dreyer Bros., Inc., a subsidiary of Burlington Northern, has just submitted to the state a preliminary engineering study and conceptual plant design for the Circle West Project. This project near Circle, Montana, would convert lignite to fertilizer-grade liquid anhydrous ammonia, or fuel-grade liquid methanol. An application for 67,000 acre-feet of water per year has been filed in conjunction with this project.

Northern Lights, Inc. had received a permit from the Federal Power Commission to study the feasibility of an hydroelectric power plant on the Kootenai River near Troy, Montana. The permit allows the Idaho utility three years to complete the study.

86. NEVADA

Presently Nevada imports approximately 25 percent of the electrical energy used in the State. Essentially all of the fuel for electric energy production is imported. There are extremely limited energy resources within the State except for the yet undeveloped geothermal and solar sources.

Existing and proposed electric generation facilities provide for both in-State use and export. In Nevada some of the existing electric generation facilities use processed municipal and industrial sewage effluent water, and this is expected to continue in some of the proposed facilities. With limited surface and groundwater supplies, water for future in-State electric energy production will probably be primarily met through the purchase and transfer of water rights from existing uses. Some potential groundwater supply for electric generation exists in the State.

Continued rapid population growth and attendant development indicates a continuing need for electric energy and other energy sources even with a major conservation program. Assuming no net import or export of electricity, water need for electric energy production is projected to approximate a four-fold increase in the period 1970-1990. The current (1976) conditions indicate the State will be continuing to increase imports of electric energy to meet its needs.

The Nevada State Water Plan Report No. 9, "Forecasts for the Future - Electric Energy", issued in August 1974, identifies projected electric energy requirements and water demands.

87. NEW MEXICO

Virtually all of the water resources of the state have been appropriated in accordance with state law and applied to beneficial use or are already committed to projects authorized or under feasibility investigation. Under New Mexico law, the water rights involved in the beneficial uses are property rights, and these rights cannot be taken for energy or any other purpose except through condemnation by federal, state or county government for a public purpose. However, under New Mexico law, water rights can be acquired by negotiated purchase or, as indicated, by condemnation and with a permit from the State Engineer the point of diversion, place or purpose of use of the right can be changed; for example, from irrigation to energy production, provided that the change will have no detrimental effect on any other water right.

In the northwestern corner of the state where most of our energy development will take place, the Department of the Interior has played a role of leadership in planning the use of the water, but has remained at all times fully sensitive to the wishes of the state. The Department has obtained water rights for the development of Navajo Reservoir, Navajo Indian Irrigation Project, San Juan-Chama Project, Hammond Project and the Animas-La Plata Project and others. Contracts for water from Navajo Reservoir have been negotiated for power and coal gasification developments in the basin and New Mexico has fully supported these developments.

Except for 26,000 acre-feet, New Mexico's share of the Upper Colorado Basin compact allotment of Colorado River water is completely committed to existing, authorized and proposed uses approved by the State.

The following major energy developments, including only those that are reasonably well advanced in planning and implementation, are being considered by New Mexico.

a. Improvement of auxiliary equipment and fuller utilization of the installed 2,075 megawatts of generating capacity at the Four Corners coal-fired steam electric plant in San Juan County-Arizona Public Service Company, et al.

b. The San Juan coal-fired steam electric plant in San Juan County; 330 Megawatts of generating capacity presently in operation; 340 megawatts of generating capacity under construction; two additional 500 megawatt units planned with construction of the first of these initiated in mid-1975 --N.M. Public Service Co., et al.

c. Four 250,000,000 cubic feet per day coal-gasification units in San Juan County--WESCO.

d. Three 250,000,000 cubic feet per day coal-gasification plants in San Juan County --El Paso Natural Gas Company.

e. One 250 megawatt gas-fired steam electric plant in Lea County expected to be in operation about 1978--New Mexico Electric Company.

It is presently anticipated that at least the initial units of each of the above coal-gasification complexes will be in operation earlier than 1982.

88. OREGON

Oregon is not currently carrying out any specific studies for determining water requirements for future energy developments. Like all of the northwestern states, the primary source of power has been

from hydroelectric projects. We are beginning to shift our almost total reliance on hydropower to a system that will be made up of both hydroelectric and thermal power generation. The hydrothermal power program will provide peaking power from the hydroelectric system as a greater amount of thermal generation comes along to supply base power.

Oregon's only commercial nuclear generating plant, Trojan, with a capacity of 1130 megawatts, started power production in December of 1975. Make up water for the hyperbolic natural draft cooling tower is provided by diversion from the lower Columbia River. Peak diversion rates are expected to be 95 cubic feet per second of water, with an estimated consumption of 22,000 acre feet a year.

Ground breaking ceremonies for the 550 megawatt coal fired thermal power plant to be located along the Columbia near Boardman, Oregon, will be March 30, 1976. This plant will be located about seven miles from the Columbia River with cooling facilities provided from Carty Reservoir which will be constructed for an evaporation pond. Ultimate plans would be for four additional 1260 megawatt nuclear fired thermal generating plants in the future. Make up water will be by pumping water from the Columbia River, with joint use facilities to provide 46,000 acre feet of storage as an equalizing reservoir in the development of an additional 22,000 acres of irrigated land. Oregon has no fossil fuel, therefore, coal must be imported. Supplies for the Carty coal fired plant are tentatively planned to be shipped by rail from fields near Gillette, Wyoming. Northwest Pipeline Company, however, is investigating an 1100 mile coal slurry pipeline from the Wyoming Fields through Boise to the plant as an alternate transportation system.

The provisions of the treaty with Canada over the Columbia River provide for additional peaking units to be installed in the existing generating plants. When all features of the treaty have been implemented the total flow of the river (99.6% of the flow past The Dalles) will be utilized in generation of power, operation of fish ladders, locks, and related facilities associated with the projects. Under the provisions of the treaty there is now 15 ½million acre feet in storage in Canada available for power generation in the United States. The Corps of Engineers in its Columbia River and tributaries study is evaluating the extent of power reduction that might occur due to increased usage of Columbia River water for municipal, industrial and irrigation purposes.

The Oregon Water Resources Board in its Ultimate Needs Study published in 1969, contained a forecast for future water requirements for power production. Low flows have in general followed these forecasts and these needs are still considered valid even though the location of some of the proposed projects has shifted.

The Oregon Nuclear and Thermal Energy Council completed a study of the suitability of sites for thermal power plants on September 5, 1972. This report was a rather detailed analysis of potential limiting parameters to power development and substantial areas of the state were excluded because of lack of available water.

There are a substantial number of hydroelectric sites left which might theoretically be built. However, the costs plus environmental problems may preclude their construction for some time to come. Oregon and the Northwest do have a large potential for pumped storage projects for peaking operations. It is unlikely, however, that any will be economic to construct for this purpose along until after 1990.

The first pump storage project in the Pacific Northwest was constructed by the U.S. Bureau of Reclamation as a part of their Grand Coulee pumping plant, with the first two units having been completed and available for service in 1974. Four additional 50 megawatt reversible units are planned for future development and will also utilize the 300 foot head between Banks Lake and the reservoir behind Grand Coulee Dam. In 1972 the Power Planning Committee of the Pacific Northwest River Basins Commission published a report prepared by the North Pacific Division, Corps of Engineers, inventorying some 242 sites suitable for 1000 megawatt developments or more. The total production, if all sites were fully developed, would be about 690,000 megawatts based on investment costs at that time of $150 per kilowatt or less.

89. UTAH

The basic policy issue in the water for energy question is when and where should the state make its presence felt in matters that have heretofore been left to the private sector. In the formulation and construction of the Huntington and Emery County power projects by Utah Power & Light Company, the necessary water supply was put together by traditional means of applying for unused water when it existed, and negotiation and purchase or rental of blocks of water originally designated for irrigation. The advantage

to this procedure is that all parties to agreements must be satisfied or contracts will not be signed.

It is significant to note that two reservoirs, Joes Valley and Ferron (millsite), were already constructed--one as a Bureau of Reclamation project and one as a State Water Board project--and both with substantial Federal funding as irrigation projects. Here the "free market" system was allowed to operate; while at the same time, State and Federally controlled projects were utilized in the mutual interest of all concerned. When there are social or environmental issues which transcend the interests of the immediate parties involved (e.g., when the bargaining power of the parties is grossly unequal or when the Federal government assumes a significant role) the State should choose to be involved.

At some time in the future, the State might take positive action to guarantee production of sufficient electric energy for in-State uses, but this seems unlikely. In the case of the Kaiparowits Power Project, the State has entered the negotiations in support of the project because it is felt to be in the best interest of the State.

Large power projects are under active study in the Kaiparowits Plateau, Fremont River Basin, the Escalante River Basin, and the Virgin River Basin. The Division of Water Resources has conducted reconnaissance level river basin studies in the Fremont and Escalante areas on the basis of these and other studies and the Board of Water Resources has made the following recommendations:

1. That the State should cooperate with Utah Power and Light Company and the irrigation water users of Emery County in making additional water available for the Emery plant, while at the same time minimizing the disruption of agricultural uses of water. This can be achieved, at least in part, by retiring the more alkaline lands, lining canals and constructing pipelines, and promoting more efficient application of irrigation water.

2. That the Kaiparowits Project continue to receive all possible State support, and that construction be started as quickly as possible. The quantity of water allocated to the project should be reduced to a value commensurate with the 3000 megawatt facilities presently contemplated. (Approximately 50,000 acre-feet annually.)

3. That a dam and reservoir be constructed on the Lower Fremont River, under the direction of the Division of Water Resources, and that it be operated and maintained by the Wayne County Water Conservancy District. To the extent legally and economically feasible, the ground water resources of the area should be developed and used conjunctively with the surface water developed by the storage project. This would essentially complete the State Water Plan approach for Wayne County. Supplemental water for irrigation in the Lower Fremont Basin would be financed largely through the sale of water for a thermal electric power plant in the Caineville area. Water developed in excess of needs for thermal power would be used to firm up irrigation supplies in the Caineville and Hanksville areas.

4. That a firm decision to allocate remaining water in the Escalante River should be delayed until power company proposals are more specific, and until decisions have been reached on Kaiparowits. Division of Water Resources studies indicate that a small power plant (430mw) might be compatible with recreation and environmental features. The Escalante River Basin, however, has received national attention as an outstanding scenic area, and developments of any kind can be expected to draw strong reaction. Considerable additional study will be necessary to justify location in this basin rather than some less sensitive area.

5. That the State should continue to cooperate with the Washington County Water Conservancy District in the formulation of plans to develop the remaining water resources of the Virgin River* in a multipurpose project.

* NOTE: The Virgin River is in the Lower Colorado River Basin, and water use limitations imposed by the Upper Colorado River Basin Compact do not apply.

The principal project feature is a large dam and reservoir at Warner Draw, where water will be stored for thermal power generation, supplemental irrigation, municipal and industrial use, and recreation.

The State has also been heavily involved in water for development of the oil shale resources of southeastern Utah. The Division of Water Resources has carried on extensive investigations leading to the proposed construction of a dam and reservoir on the White River near Watson. This reservoir would store water committed by the State for test tracts U-a and U-b, and it is contemplated that Indian water would be stored and released for use on approximately 13,000 acres of Indian lands. Recreational facilities would be provided by the reservoir, and the dam would provide flood protection, silt retention, and store sufficient water for future uses.

The Division of Water Resources is continuing the design work on the dam and reservoir, and negotiations to finalize the project are in progress with the Indian interests, the oil companies, the conservancy districts, the Bureau of Reclamation, and the State of Colorado. Inasmuch as the time schedule for full-scale oil shale production is sometime in the future, decisions as to the full allocation of water for that purpose can be delayed at least for a short period of time.

90. WASHINGTON

In the State of Washington there are ongoing water availability studies to determine how water for projected power requirements can be supplied. Most of these needs are currently being considered in state-federal studies conducted under the aegis of the Pacific Northwest River Basin Commission.

There are three major external study efforts from the PNWRBC underway at this time being conducted by the State of Washington. Two of these studies involve sitings of two twin nuclear generating units, the first at Satsop, Washington (WNP 3 and WNP 5) and the second at Sedro Wooley, Washington (Skagit 1 and 2). Water supply and water quality effects are among the factors being given consideration.

The evaluations are being performed by the Thermal Power Plant Site Evaluation Council, a State of Washington Council, and final determination should be completed in May or June of 1976.

The third study involves a preliminary evaluation of a proposed Power Park Site on the Columbia River at John Day Reservoir. This study is also being conducted by the Thermal Power Plant Site Evaluation Council. The objective is to determine the carrying capacity of the site for a mix of fossil fueled-nuclear fueled units. Air quality, water availability and water quality impact are being closely studied.

Two pumped storage projects are the subject of two additional studies which are well along in the middle reach of the Columbia River. The water use would be non-consumptive and would only alter the flow regime and not the total amount of water available.

91. WYOMING

The Wyoming Framework Water Plan identifies a considerable water supply that can be developed for energy resource development by regulating otherwise uncommitted compact surplus water supplies. This can be done even while developing very large quantities of water supplies for irrigation and other uses. The challenge is to develop these presently unused surplus water supplies, rather than let industry purchase and transfer already developed irrigation water rights.

The 1975 legislature passed the Wyoming Water Development Program "..to foster, promote and encourage the optimum development of the State's human, industrial, mineral, agricultural, water and recreational resources...the program shall encourage public irrigation facilities, reducing flood damage, abating pollution, preserving and developing fish and wildlife resources, protecting and improving public lands and shall help make available the waters of this State for all beneficial uses, including but not limited to municipal, domestic, agricultural, industrial, hydro-electric power and recreational purposes.." Through this program, the State of Wyoming anticipates multiple purpose water resources development to meet the State's future water needs.

The State of Wyoming has purchased storage capacity in Fontenelle Dam on the Green River (Colorado River Basin) to help meet the future water needs, and a feasibility study has been conducted of

providing additional reservoir storage in the Green River Basin.

Recognizing the potential for industrial water uses in Northeastern Wyoming, the State conducted a prefeasibility investigation of Powder River storage development for that Yellowstone River tributary. The State also encouraged industries to join with local irrigation interests to construct storage reservoirs as joint ventures.

The State Engineer's Office is coordinating activities related to the Old West Regional Commission's study of recharge to the Madison Limestone in Northeastern Wyoming.

92. "Oil Shale"

This report is a 1974 view of the oil shale industry by the Editors of the Daily Sentinel. Areas of discussion include: need, development, environment, processes, federal leases, water, growth, planning, legislation, and ownership. The water portion of the report is mainly concerned with water availability and water quality.

93. "Far West's Shortage of Water May Block Many Energy Schemes"

This article appeared in the Wall Street Journal on December 16, 1974. The article pointed out concerns over the availability of water for energy in the West. Examples were given of considerations relating to the subject in Wyoming, Montana, South Dakota, Colorado and Utah. The articles also discusses federal government efforts to augment the flow of the Colorado River through cloud seeding.

94. "Possible Impacts of Oil Shale Development on Land Resources"

This article published in the Journal of Soil and Water Conservation, March-April, 1974, describes the land disturbances and impacts on water yield of the oil shale industry.

95. "Water and the Energy Crisis"

This paper presented at the First World Congress on Water Resources in September 1973 describes how industry and energy development are limited by water supply. The paper considers several factors that relate to energy needs. The industrial potential of the Upper Missouri River Basin is estimated. The water for energy issue receives special treatment in a section on coal fired steam electric power plants in the Colorado River Basin, Arizona, Colorado, New Mexico, Utah and Nevada.

96. "Wringing out the West"

In the Enviroment of September 1975, identified as vol. 16 - no. 7, the cover headlines the words, OUTLOOK FOR WATER IN THE ROCKIES. On page 10 there is an article entitled, "Wringing out the West" which analyzes the potential effects that energy development could have on down stream flows of the Missouri and Colorado Rivers in the decades ahead.

97. "Slurry Pipelines: The Most Efficient Way to Carry Coal"

Pipeline Industry is a publication relating to engineering, construction and operation of pipelines and gas distribution. In the issue published in May 1975 on page 29, there is an article entitled, "Slurry Pipelines: The most Efficient Way to Carry Coal." The article analyzes the economics of slurry pipelines and it states that beyond 500 miles and 10 million tons per year volume the slurry pipeline economics steadily increase over unit trains and EHV transmission.

98. "Water Prospects for the Emerging Oil Shale Industry"

On April 18, 1975, Felix L. Sparks, Director of the Colorado Water Conservation Board, presented a paper to the Seventh Oil Shale Symposium held at the Colorado School of Mines. Mr. Sparks identified his subject as water prospects for the emerging oil shale industry. In the paper, an analysis is made as to the requirements and supplies in the Colorado River Basin of water resources that could be used to support the oil shale industry.

99. "Energy and Water, the Indispensible Intertie"

Jack Horton, Assistant Secretary of Interior, spoke at the Quarterly meeting of the Upper Missouri River Basin Council in Bloomington, Minnesota on February 11, 1976. Secretary Horton identified his

subject as "Energy and Water - The Indispensible Intertie." Headings from his discussion are: The new coal leasing policy, toward a national policy, total water management, the garrison diversion project, Interior - Army water marketing agreement, water - the key to energy development, export policy, slurry pipelines, and the coal and water intertie.

100. "Water and the Energy Crisis"

The April 1974 publication of the American Water Resources Association entitled, "Water Resources Bulletin" - volume 10, no. 2, carried an article on page 220 entitled "Water and the Energy Crisis." The paper discusses technological aspects, political-social considerations, economic and environmental issues, energy and water resource planning process and research needs.

101. "Proceedings of the Workshop on Research Needs Relating to Water for Energy"

In October of 1974, a workshop was sponsored by the Water Resources Center of the University of Illinois at Urbana - Champaign, to identify research needs related to water for energy. The proceedings of this workshop have now been published and are available in a November 1974 publication, which has been identified as research report no. 93. Subjects such as coal conversion, water requirements for synthetic fuels, legal aspects of water for coal gasification, heat dissipation for large power plants, social, political and industrial aspects of coal utilization, were discussed at the workshop.

102. "The Role of Water in the Energy Crisis"

A conference was held on October 23-24, 1974 at Lincoln, Nebraska. The Conference was entitled, "The Role of Water in the Energy Crisis." The proceedings of the conference have now been published by the sponsor of the conference, Nebraska Water Resources Institute. Subjects include the role of water in the energy crisis, political - social aspects of energy-water relationships, economic aspects of resource use with special reference to energy and water, environmental aspects of energy-water relationships, role of water research in energy crisis and technological aspects of energy-water relationships.

103. "Water Availability For Energy - Upper Colorado River Basin"

Dee C. Hansen, Utah State Engineer, addressed the American Society of Civil Engineers at their national convention in Denver, Colorado during the period between November 3rd and November 7, 1975. The subject of Mr. Hansen's address was, "Water Availability For Energy in the Upper Colorado River Basin." Topics discussed include: (1) the law of the river, (2) legal restraints, (3) facing future developments, (4) state water laws, (5) Indian water rights, and (6) alternative sources of water.

124f. Nevada - 11d(8), 11d(11), 11f(16), 31a, 86. 95.
124g. New Mexico - 8q, 11d(11), 11e(6), 11f(14), 11f(15), 31a, 87, 95.
124h. North Dakota - 5m, 9a, 11e(1), 11f(2), 11f(25), 51a.
124i. Oregon - 6d, 8p, 11d(12), 11f(16), 31a, 88.
124j. South Dakota - 5m, 9a, 11e(1), 11f(1), 11f(2), 11f(25), 18a, 51a, 93.
124k. Utah - 9a, 11d(6), 11d(11), 11d(17), 11e(8), 11f(6), 11f(17), 11f(18), 11f(19), 31a, 89, 92, 93, 95.
124l. Washington - 6d, 11f(29), 31a, 90.
124m. Wyoming - 6d, 8m, 8o, 9a, 11b(1), 11d(5), 11d(16), 11e(1), 11e(8), 11f(1), 11f(12), 11f(13), 11f(21), 11f(22), 11f(23), 11f(24), 11f(25), 11f(26), 11f(27), 14f, 18a, 31a, 51a, 53a, 91, 93.

125. Strip mining reclamation, revegetation of mined areas and runoff effects - 2c, 4b, 8c, 8d, 8j, 8n, 8o, 11b(2), 11c(2), 11f(5), 11f(7), 11f(19), 11f(28), 11f(31), 11f(32), 11f(36), 26b, 34a, 41b, 54a.

126. Water requirements for energy, energy demands and regional assessments - 4b, 4c, 4d, 4e, 4f, 4g, 4h, 7b, 8f, 9c, 11d(1), 11d(6), 11d(13), 11d(16), 11e(5), 11e(9), 11f(3), 11f(4), 11g(2) 14d, 15a, 17a, 17b, 17c, 17d, 20b, 22a, 27a, 28a, 31a, 42a, 49a, 51a, 59a, 65a, 93, 95, 96, 99.

127. Water Savings - 4a, 8p, 11d(2), 16b, 42b.