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# **WATER RESOURCE PROBLEMS AND RESEARCH NEEDS OF NEW MEXICO**

Technical Completion Report  
Project No. A-041-NMEX

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WATER RESOURCE PROBLEMS AND RESEARCH

NEEDS OF NEW MEXICO

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TECHNICAL COMPLETION REPORT

Project No. A-041-NMEX

New Mexico Water Resources Research Institute  
*in cooperation with*  
New Mexico State University, Las Cruces, New Mexico

July 1974

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## CHAPTER I

### INTRODUCTION

There are many water problems in the State of New Mexico, and research of many kinds will be required in order to solve them. The purpose of this study has been to obtain information that will aid in the development of a coordinated program of water resources research in New Mexico. The New Mexico Water Resources Research Institute, through programs with the Office of Water Resources Research, the Environmental Protection Agency, and others, has a key role in the formulation of an effectively defined planning and implementation program for water resources research in the State. This project will aid the Institute in planning and implementing its water research programs, in coordinating water research within the State University System with the needs of the State, and in pointing out those areas where improved technology transfers are needed.

Research has many uses, two of which are the generation of new information and methodologies that can be used to solve problems, and the transfer of information that is already known about a problem. Both are legitimate and important uses. In the field of water resources, a research tradition has not yet fully developed which would allow the communication and research planning necessary between researchers and the water management practitioners that would provide timely, beneficial, and usable information to the potential users. Frequently, potential researchers may not be sufficiently aware of the various water problems in enough detail to formulate a research investigation, or they may be unaware that a particular problem exists. Also, researchers and water management practitioners often may be unaware of each other's efforts.

There has been a general resistance to the planning of research, which originates partially from the traditionally independent personality and outlook of the researchers, and partially from the common attitude that research, because of its inherent uncertainties, cannot be planned in a realistic manner. Another historical tendency has been to concentrate first on advancing the state-of-the-art and only then considering uses for the newly developed information, on the assumption that whatever research produces is worthwhile and the burden of applying it rests with the potential user.

The resistance to research planning has not been limited to the researchers, however, for research problems cannot be defined effectively without knowledge of the needs of those who are to be served. Often, those experiencing water problems may be unaware of the contribution a researcher could make. Also, solutions to particular problems may have been found, and in some cases may be well known, but are not being applied. New and additional research efforts may be required to find out why solutions are not being applied, or to improve the mechanisms for the transfer and implementation of the knowledge.

This study is an attempt to inventory and rank the problems, indicate the research needs, and aid in the coordination of water resources projects in the State of New Mexico.

## OBJECTIVES

The objectives of this research were to identify, assess, and establish a priority ranking of the State's water problems and related research needs. Several specific objectives were formulated, as follows:

- (1) to establish state water research need priorities,
- (2) to relate the research needs to ongoing and authorized programs, which would identify potential areas of duplication or collaboration, and
- (3) to identify information transfer needs and methods.

## METHODOLOGY

In order to identify the water problems and related research needs of New Mexico, any of several methods, each based on expert opinion, could have been employed.

The approach used included a survey of water-user organizations by mail questionnaire and personal interviews with State, federal, and major water-user organization officials. The federal and State government agencies, which are concerned with the management of the State's water resources, were considered to provide an informed and representative inventory of problems and research needs. This identification was supplemented with the inventory by mail questionnaire, thus allowing local, more specific, and in some cases newly emerging problems to be included. Because an establishment of the State's priority research needs was intended, the priority ranking of problem areas and research needs compiled were identified by State agency personnel.

A list of persons interviewed during the course of the project is included in the Appendix. A listing of the research projects and resultant publications and the eighteen New Mexico Water Conference proceedings themes and presentation topics was compiled and is also included in the Appendix.

## GENERAL WATER SITUATION

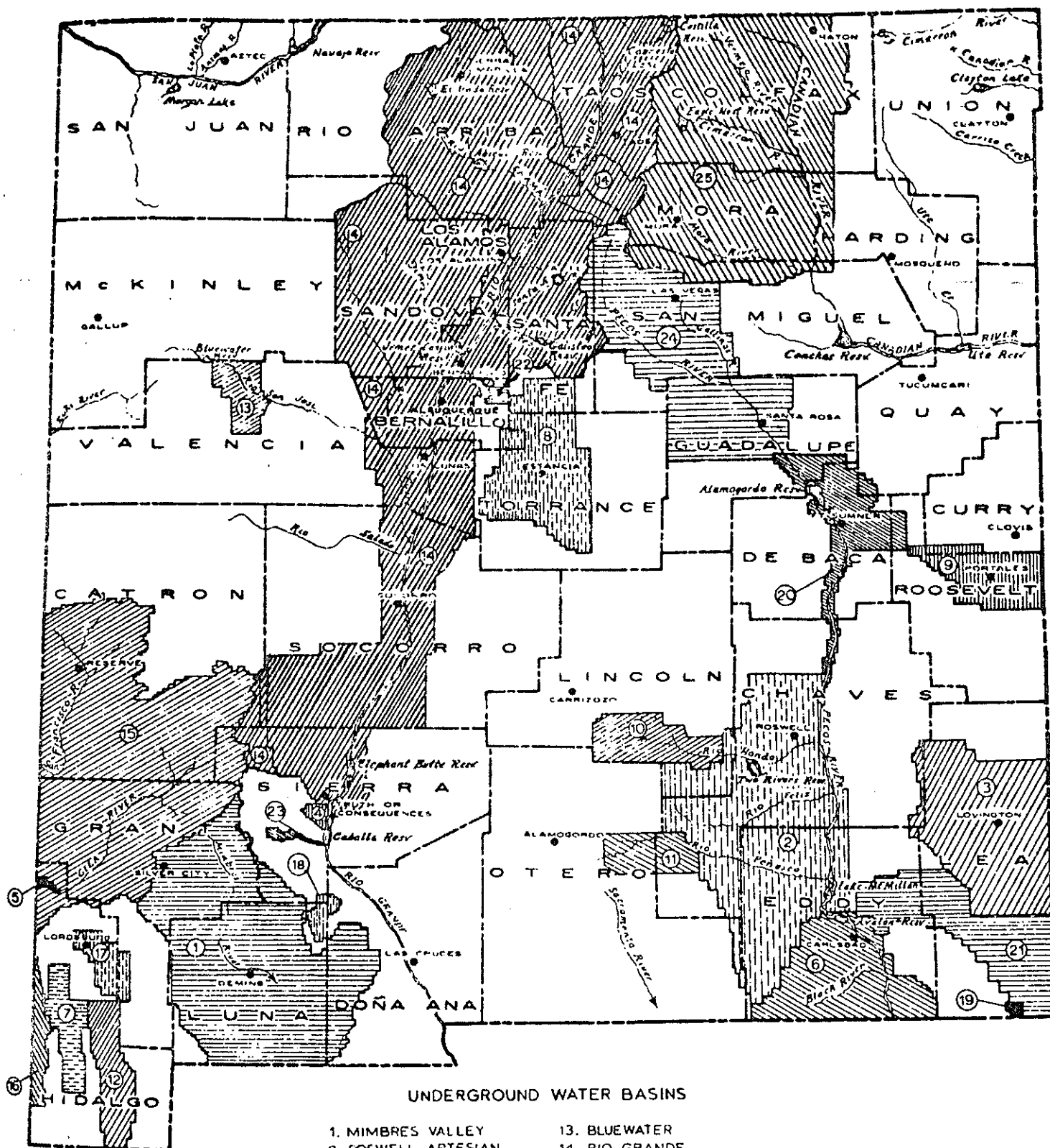
Before a discussion of water problems and related research needs, an understanding of the State's hydrologic characteristics and patterns of water use would be helpful.

Water is a vital resource to the State of New Mexico, primarily because of its scarcity. In 1961, the U. S. Senate Select Committee on Water reported the Upper Rio Grande and Pecos Basin to be the shortest of water in relation to projected demand in 1980 of any basin in the continental United States (U. S. Senate, 1961): This area includes approximately 75,000 square miles, or about 62 percent of the State. The Colorado Basin was reported as second in amount of projected shortage: This basin included about 23,000 square miles, or about 19 percent of New Mexico. Thus, these approximately 98,000 square miles comprising about 81 percent of the State are projected to have the greatest water supply or availability problems in the nation. It is this shortage of water in relation to the demand which has caused, and will cause, many of New Mexico's water problems.

New Mexico law provides that the surface and underground waters of the State belong to the public and are subject to appropriation for beneficial use. Such use is the basis, the measure, and the limit to the right to use water, and priority in time gives the better right. The underlying principle is known as the prior appropriation doctrine of water rights. In New Mexico the doctrine has been followed by custom, court declaration, and statute. The mere physical presence of water upon, adjacent to, or under land does not confer ownership of the water or a right to its use upon the owner of the land (Reynolds, 1973). Water rights in New Mexico belong to the public and are administered by the State Engineer. The jurisdiction over the appropriation and use of the waters of an underground stream, channel, artesian basin, reservoir, or lake may be assumed by the State Engineer when he proclaims them to have reasonably ascertainable boundaries. The appropriation and use of surface water closely parallel those for appropriating ground water. As of September 7, 1973, the State Engineer had proclaimed, or declared, 25 such "underground water basins" (Figure 1). Most of the surface water in the State has been appropriated, and activity in recent years has been concerned chiefly with ground water development.



# DECLARED UNDERGROUND WATER BASINS IN NEW MEXICO



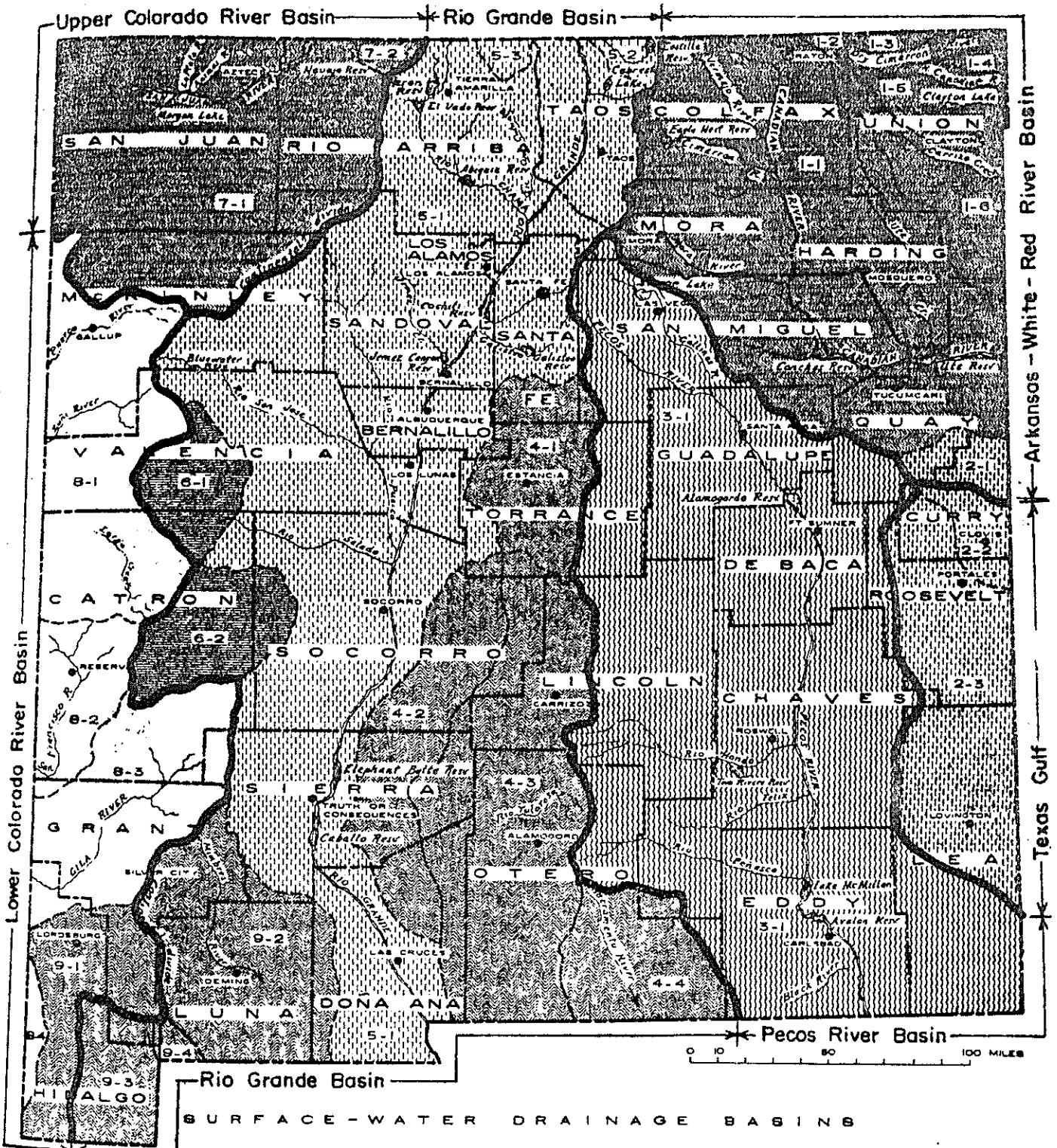
## UNDERGROUND WATER BASINS

- |                     |                        |
|---------------------|------------------------|
| 1. MIMBRES VALLEY   | 13. BLUEWATER          |
| 2. ROSWELL ARTESIAN | 14. RIO GRANDE         |
| 3. LEA COUNTY       | 15. GILA-SAN FRANCISCO |
| 4. HOT SPRINGS      | 16. SAN SIMON          |
| 5. VIRDEN VALLEY    | 17. LORDSBURG VALLEY   |
| 6. CARLSBAD         | 18. NUTT-HOCKETT       |
| 7. ANIMAS VALLEY    | 19. JAL                |
| 8. ESTANCIA         | 20. FORT SUMNER        |
| 9. PORTALES         | 21. CAPITAN            |
| 10. HONDO           | 22. SANDIA             |
| 11. PEÑASCO         | 23. LAS ANIMAS CREEK   |
| 12. PLAYAS VALLEY   | 24. UPPER PECOS        |
|                     | 25. CANADIAN RIVER     |

Figure 1.

New Mexico contains portions of the headwaters of three of the principal drainage systems of the United States: Colorado River (Upper and Lower Colorado River Basins), Mississippi River (Arkansas-White-Red River Basin), and Western Gulf of Mexico tributaries (Texas Gulf, Rio Grande, and Pecos Basins) (see Figure 2). There are also 10 areas from which surface water is not normally discharged (Figure 2) (Reynolds, 1973).

New Mexico is generally considered a semi-arid area. Precipitation is low, ranging from about 8 to 35 inches annually, and is characterized by wide variability from place to place and from time to time. This variability creates as much a part of the problem as the scarcity of water itself. The average annual precipitation of about 13 inches is much less than the rate of evaporation from open water surfaces. Of the roughly 85 million acre-feet of precipitation, only about 3 million acre-feet appears as runoff in streams annually: the remainder returns to the atmosphere through evaporation and evapotranspiration, or recharges underground aquifers. In addition to this net water yield, New Mexico receives annually, in a period of normal water supply, about 2.5 million acre-feet of stream flow from other states, primarily Colorado. In 1972, approximately 1.27 million acres of cropland was irrigated; 342,340 acres from surface water sources, 750,980 acres from ground water sources, and 176,730 acres from a combination of both surface and ground (Lansford and Sorensen, 1973). Agriculture, therefore, is the largest user of the State's water resources, depleting about 1.7 million acre-feet annually (Lansford et al., 1973).



**SURFACE-WATER DRAINAGE BASINS**

BASIN	AREAS IN SQ. MILES	BASIN	AREAS IN SQ. MILES	BASIN	AREAS IN SQ. MILES
<b>ARKANSAS RIVER BASIN</b>					
1-1, CANADIAN RIVER	13,066	<b>CENTRAL CLOSED BASINS</b>			
1-2, PURGATOIRE RIVER	90	4-1, ESTANCIA BASIN	2,220	<b>SAN JUAN RIVER BASIN</b>	
1-3, DRY CIMARRON RIVER	710	4-2, JORNADA DEL MUERTO	3,475	7-1, SAN JUAN RIVER	9,495
1-4, CARRIZOZO CREEK	220	4-3, TULAROSA BASIN	6,540	7-2, NAVAJO RIVER	245
1-5, NORTH CANADIAN RIVER	1,040	4-4, SALT BASIN	2,370	<b>TOTAL</b> 9,740	
1-6, CARRIZO CREEK	1,980	<b>RIO GRANDE BASIN</b>			
<b>TOTAL</b>	<b>17,066</b>	5-1, RIO GRANDE	25,390	<b>LOWER COLORADO RIVER BASIN</b>	
<b>SOUTHERN HIGH PLAINS</b>					
2-1, RED RIVER	666	5-2, COSTILLA CREEK	230	8-1, LITTLE COLORADO RIVER	5,310
2-2, BRAZOS RIVER	721	5-3, RIO SAN ANTONIO	260	8-2, SAN FRANCISCO RIVER	1,906
2-3, LEA PLATEAU	4,766	<b>TOTAL</b> 25,880			
<b>TOTAL</b>	<b>6,143</b>	<b>WESTERN CLOSED BASINS</b>			
<b>PECOS RIVER BASIN</b>					
3-1, PECOS RIVER	25,922	6-1, NORTH PLAINS	1,000	<b>SOUTHWESTERN CLOSED BASINS</b>	
<b>HIDALGO BASIN</b>					
9-1, ANIMAS BASIN	2,430	<b>9-2, MIMBRES BASIN</b>			
<b>9-3, PLAYAS BASIN</b>					
<b>9-4, WAMEL BASIN</b>					
<b>TOTAL</b> 6,420					
<b>STATE TOTAL</b> 121,666					

Figure 2.

## BACKGROUND OF THE INSTITUTE

The New Mexico Water Resources Research Institute was officially organized and approved by the New Mexico State University Board of Regents in February of 1963. In September of 1963, the Governor officially designated New Mexico State University as the location of the State Water Resources Research Institute. The Institute was among the first to receive official federal designation and authorization to operate under the provisions of section 100 of the Water Resources Research Act of 1964, P.L. 88-379. The Institute office was opened in March 1965, shortly after the Act became effective.

The Water Resources Research Act provided for federal appropriations to the Institute beginning in fiscal year 1965, with \$75,000 allotted to each state institute. The allotment to each in FY 1966 and 1967 was \$87,500, and since FY 1968 has been \$100,000. The Act was amended by P.L. 89-404 and P.L. 92-172 in 1971 which authorized an increase from the \$100,000 to a \$250,000 allotment for each institute annually, and also provided for additional information dissemination activities and responsibilities.

## OBJECTIVES OF THE INSTITUTE

The Institute is essentially a planning and coordinating activity for research and graduate training in the area of water resources, representing all of the universities and colleges in the State of New Mexico. The objectives of the Institute may be stated as follows:

- (a) To plan and coordinate the water resources research and training activities involving faculty and facilities of the various colleges and universities in the State.
- (b) To arrange and conduct water resources research appropriate to the role and scope of the State's colleges and universities for the benefit of the State and the Nation including those sponsored by
  - (1) The Office of Water Resources Research
  - (2) Other federal agencies
  - (3) State agencies

- (4) Quasi-public organizations
- (5) Industry
- (c) To arrange for seminars and conferences involving persons having interest and responsibilities in the water problems of the State.
- (d) To provide for publication and dissemination of the results of research conducted by the Institute and other information which bears upon the water resources of the State.

#### SCOPE OF THE INSTITUTE

The New Mexico Water Resources Research Institute administers the program of water resources research and training authorized by the Water Resources Research Act of 1964 (P.L. 88-379) as amended, as it applies to New Mexico. The Office of Water Resources Research (OWRR) administers the total program of the Act. The following is quoted from the preamble to the Act.

"In order to assist in assuring the Nation at all times of a supply of water sufficient in quantity and quality to meet the requirements of its expanding population, it is the purpose of the Congress, by this Act, to stimulate, sponsor, provide for, and supplement present programs for the conduct of research, investigations, experiments, and the training of scientists in the fields of water and of resources which affect water." Consistent with this purpose, major program objectives include: developing through research new technology and more efficient methods for resolving local, State and Nationwide water resource problems; training water scientists and engineers through their on-the-job participation in research work; and facilitating water research coordination and the application of research results through dissemination of information about ongoing and completed research. OWRR does not maintain its own laboratories or perform "in-house" research.

Under Title I of the Act, OWRR provides non-competitive annual funds allotments to support one State university water resources research and training institute in each State and in Puerto Rico, the District of Columbia, the Virgin Islands, and Guam. These institutes compete for additional OWRR funds to support additional specific research project work on a dollar-for-dollar matching-fund basis. Other universities and colleges may participate in the Title I program work of the designated State university institutes. It is the duty of each such institute to plan and conduct competent research of either a basic or practical nature, or both, in relation to water resources; develop annual research programs in close consultation and collaboration with leading

water officials within the State; provide for the training of scientists through such research; and interpret and disseminate information about research results.

Research and training by the Title I State institutes may include, without being limited to, aspects of the hydrologic cycle; supply and demand for water; conservation and best use of available supplies of water; methods of increasing such supplies; and economic, legal, social, engineering, recreational, biological, geographic, ecological, and other aspects of water problems, and scientific information dissemination activities. Institute activities must give due regard to the varying conditions and needs of the respective States, to water research projects being conducted by agencies of the Federal and State Governments, and others, and to avoidance of any undue displacement of scientists and engineers elsewhere engaged in water resources research.

Under Title II of the Act, additional grants and contracts are made with academic, private, public or other institutions, organizations and individuals having water research competence for support of urgently needed water resources research work relating to the mission of the Department of the Interior. Annually or more frequently, OWRR identifies priority research subjects for Title II support.

#### PROGRAM DEVELOPMENT AND REVIEW BOARD

This Board originally was designated as the Executive Board. However, the new title, adopted in January, 1967, more accurately describes its function. It recommends areas for research concentration, reviews and recommends the relative importance and quality of research proposals, reviews the technical procedures suggested, and recommends means by which certain phases of one project may be coordinated with work being done in other projects in the State. The Board also recommends the projects which qualify on a technical basis and recommends the priority for project funding each year.

The Board includes scientists at New Mexico State University, the New Mexico Institute of Mining and Technology, and the University of New Mexico.

#### INSTITUTE PROGRAMS

The New Mexico Water Resources Research Institute administers the Title I program of the Water Resources Research Act as it applies to New

Mexico. The Title I program consists of the Section 100 Annual Allotment Program and the Section 101 Matching Grant Program. Assistance, support, and administrative help are also provided to researchers wishing to apply for Title II support under the Act.

The Institute sponsors research to be conducted in the principal investigator's own department. He uses his own office and the laboratory space available to him in his department. This avoids any duplication of research equipment and laboratories which might be required if the research were to be conducted in laboratories provided by the Water Resources Research Institute.

When a researcher wishes to request support for a water research project from the Water Resources Research Institute, he first contacts his department head and determines the amount of time he might get released for the project. This might vary from a very small percent to as much as 100 percent of his time, depending on the size of project and the importance of the problem to his department and to the State. When this professor completes the WRRI project, his time is again picked up by the department for teaching duties, or for other research work.

#### SECTION 100--ANNUAL ALLOTMENT

Title I, Section 100, of the Water Resources Research Act provides for annual allotments of funds (grants) to the 50 States and Puerto Rico for assistance in establishing and carrying on the work of a competent and qualified water resources research institute at one college or university in each State. The annual amount currently authorized for each of these 51 State institutes is \$250,000. For three new "State" institutes, the District of Columbia, the Virgin Islands, and Guam, added by P.L. 92-175, the annual authorization is \$125,000 for fiscal year 1972, \$200,000 for 1974, and \$250,000 thereafter.

The function of such institute is to conduct research, investigations, and experiments of either a basic or practical nature, or both, in relation to water resources; provide for the training of scientists through such research, investigations and experiments; and interpret and disseminate information, about research results deemed potentially significant for solution of water resources problems, to persons who need such information and can apply it. State institutes submit proposed annual research programs for OWRR review and approval pursuant to OWRR guidelines provided to the institutes. In addition to specific research project reports, they also submit State institute reports to OWRR dealing with accomplishments, fund utilization, and related matters. Annual programs submitted by the institutes to OWRR for approval must

include assurance satisfactory to OWRR that such programs were developed in close consultation and collaboration with leading water resources officials within the State to promote research, training, and other work meeting the needs of the State.

#### SECTION 101--MATCHING GRANT

Title 1, Section 101, of the Water Resources Research Act provides for grants to the State institutes to match, on a dollar-to dollar basis, funds made available to the institutes by State or other non-Federal sources to meet the necessary expenses for specific water resources research projects which could not otherwise be undertaken. The annual amount currently authorized for appropriation is \$5,000,000. The State institutes compete for Sec. 101 funds made available by Congressional appropriation by developing and submitting specific research proposals pursuant to OWRR guidelines provided to the institutes.

Participation in the Title I Program by Universities and Colleges Other than the State Institute University. Other universities and colleges within a State may participate in the Section 100 annual allotment and Sec. 101 matching grant programs of the State institutes. This is accomplished by having the State institute agree to include other-university (or college) research project proposals in the State institute submittals of research programs and project proposals to OWRR for evaluation and approval. Researchers and research program administrators of other universities and colleges who are interested in exploring the possibility of becoming active participants in these programs should contact the institute for their State. All OWRR Title I grant funds go to the designated State institutes; payments to other-universities participating in the program are received from the State institute university pursuant to mutually acceptable memorandums of agreement that satisfy university requirements as well as applicable State and Federal requirements.

#### TITLE II PROGRAM

Title II of the Water Resources Research Act as amended provides for grants, matching grants, contracts or other arrangements with educational institutions, private foundations, or other institutions; with private firms and individuals; and with local State and Federal Government agencies, to undertake research into any aspects of water problems related to the mission of the Department of the Interior which may be deemed desirable and are not otherwise being studied. OWRR encourages and welcomes non-Federal cost sharing for research projects approved for OWRR support; particularly, cost sharing is encouraged where the research is directed towards finding solutions to urgent water problems largely confined to a specific local area or State. Federal regulations require that under most circumstances universities and other institutions receiving Title II research grants shall share in the research costs.

Title II of the Act requires that before research projects tentatively selected for OWRR support under this Title may be funded,



they must lie before the Senate and House Interior and Insular Affairs Committees for 60 days.

The amount authorized for Congressional appropriation for Title II "Additional Water Resources Research" projects is \$10,000,000 for each of the fiscal years 1972-1976.

Title II research project proposals may be submitted directly to OWRR. Interested persons may request OWRR to place them or their organization on OWRR's mailing list to receive subsequent announcements regarding OWRR's interest in receiving additional Title II water resources research proposals. When such announcements are made they will normally include examples of priority research subject areas. Additionally, OWRR will also have available the related guidelines, instructions and forms. The State institutes can also provide helpful information regarding the Title II Program.

Proposals for research are normally accepted by the Institute for the Annual Allotment Program during January of each year, and for the Matching Grant Program prior to September 1 of each year. Proposals for research under the Title II program may be submitted to OWRR at any time, however, OWRR normally specifies a date (normally in January of each year) by which those received will be given primary consideration.

#### RESEARCH PRIORITIES

Water Research needs are different for different areas of the nation and continually change through time. Some areas of the nation are concerned with excesses of water and others with scarcities. In other areas, water pollution studies are of priority concern. As some problems are solved others emerge in importance. Thus, priority lists must be continually evaluated and adjusted to changing conditions and times. The following list of problems are not intended to be unaltered, but only as a basis for evaluation and change.

Two lists of research subjects are included. The first is the Office of Water Resources Research subjects for Title II support for the 1975 fiscal year. This list is continually updated and modified by OWRR from year to year. The second is a list of research subjects obtained from the survey of New Mexico water problems. These problems were further ranked by state agency personnel: New Mexico's ten most important water problems.

## OWRR PRIORITY RESEARCH SUBJECTS

The Title II research program of the Office of Water Resources Research will be directed primarily toward support of certain current priority objectives of the Department of the Interior. These include:

- (a) Solving of Energy Problems.
- (b) Encouraging Indian Self-Determination and Improvement in the Quality of Life on Indian Reservations.
- (c) Solving Land Use Problems.
- (d) Promotion of Efficient Allocation and Conservation of Scarce Water and Water-Related Resources in a Manner Compatible with Environmental Considerations. Developing means of achieving more efficient resource management such as reuse and recycling of water, reassessing the economic value of additional agricultural development and improved irrigation efficiencies in order to save resources, thus reducing the need for large capital investments of the future.
- (e) Improving the Quality of our Physical Environment.

In addition to the above Departmental objectives, OWRR has again identified general subject areas of prime interest. These are listed below, with examples of specific research requirements.

Many water-related resource problems are applicable to both Departmental priority objectives and OWRR subject areas of prime interest. Proposals for research which offers a high assurance of increased effectiveness in dealing with such dualistic problems will receive strong consideration for funding.

OWRR will also consider funding other subject areas of research not included on this priority list if the research proposal provides convincing reasons that the subject area is of high priority and within the purview of Title II of the Water Resources Research Act of 1964, as amended.

1. Improvement of Water Resource Planning, Managerial, Financial, Operating and Regulatory Policies. In approaching this problem, research goals should be to provide a basis for establishment of improved mechanisms, including evaluation of alternative means of augmenting and conserving supply, for water resources planning, implementation of plans, and to improve management effectiveness through lessening of conflicts, uncertainties, and confusion among claimants to the resource.

2. Water Resources Policy and Political Institutions. Understanding of policy and institutional problems is indispensable to sound water resources management by both the public and private sectors of the Nation. Research is needed on how institutional policy is measured and formulated and what policies and arrangements are conducive to sound water management. Among the questions to which research could be directed are those involving current policies and institutions. The river basin as a water management unit needs further evaluation with respect to the compatibility of water resources management objectives and the needs of regional economic development.

3. Hydrologic Systems Analysis. The application of operations research tools such as mathematical modeling and simulation, optimization and design theory need to be assessed and further explored in relation to hydrologic events and to planning of surface and ground water resources development.

4. Urban and Metropolitan Water Resources Problems. Research is needed on urban hydrology and the effect of man's activities on water. Such research could include evaluation of the impact of urbanization on the frequency and magnitude of flood peaks, reduction of low flows, decrease in natural ground water accretion, impairment of water quality, erosion, etc., and development of methodology and technology to cope with such problems.

5. Ecologic Aspects and Environmental Consideration of Water Resources Planning and Management. Improved means of identifying, assessing and predicting ecologic impacts of water development such as dam building, drainage, irrigation, dredging, filling, channelization, and weather modification are needed. Conjunctive ecological studies designed to minimize harmful effects and optimize the beneficial effects of these water developments on the environment are also indicated.

6. Evaluation of Economic Importance of Various Uses of Water, Cost Allocation, Cost Sharing, Pricing and Repayment. Methodologies are needed for estimating future water demands in time, place, and quality with full consideration given to the economic relationships between supply and demand as well as the impact of new technologies. Research is needed for improving the methods used in evaluating primary, secondary and externality benefits of water resources projects.

7. Analysis and Evaluation of Water Resources Projects. Benefit-cost analysis has been the principal tool for evaluation of public investment

programs, including watershed and water resources programs. It has ranked projects and programs in terms of the objective of economic efficiency only. Research is needed to determine appropriate alternatives and multi-objectives which will insure that presently unquantified environmental amenities and values may be given appropriate considerations. Evaluation of methods to quantify values in terms of appropriate objectives and assigning weights to these values is needed so that alternative objectives and/or combinations of objectives can be compared.

8. Ground-Water Supply, Management, and Protection. Research is needed on management methods and techniques to protect the ground-water resource from degradation and overdraft; also to insure its availability and safety for domestic, municipal, industrial, and agricultural purposes, and to accomplish the integrated management of surface and ground water resources. In many areas over the Nation, productive aquifers find limited use because the quality of the native ground water is unacceptable or the water has become contaminated. Many constituents or properties imparting objectionable tastes, odors, or esthetic traits exceed allowable limits. Better techniques should be researched as to feasibility of water spreading and well injection in various surficial earth materials and aquifers. Research is particularly applicable in regions where the surficial materials are of low permeability. Research is needed also on the geochemical effects of artificial ground-water recharge.

Regarding the degradation of ground-water quality by contaminants, basic research is needed on the geochemistry--reactions among water soil and rock materials, and contaminants in the aquifer system.

A serious deficiency of aquifer system models is the inability to portray accurately fluid movement in the unsaturated zone, losses from the system by evapotranspiration, and accretions by infiltration or recharge. This aspect of fluid movement also has an important influence on surface runoff. Research is needed on the physics of fluid movement and solute interactions in unsaturated granular media.

9. Protection and Rehabilitation of Estuarine Resources. Research is needed to develop criteria, standards and guidelines for including ecological effects in planning for water resource development of estuaries and coastal bays, such as: dredging, filling, dams, diversions, land-cut canals, hurricane barriers, and waterfront finger-type developments. These studies

should attempt among other things to assess the biological effects of these developments by changing temperature, salinity, flow regimes, circulation, flushing and sedimentation, and destruction of vegetation.

10. Thermal Loading Problems. With the expected increase in number of electric generating plants and the consequent thermal loading of rivers, lakes, and estuaries, increased research attention is needed to develop new or improved approaches to physical mixing and thermodynamics of the heated discharges; in development of economically competitive alternatives to use of once-through water as a heat-transfer medium; on biologic, ecologic, environmental and sociologic impacts, on types and quantities of data required to properly evaluate facility sites and to choose among alternative sites; on adequacy of regulations and procedures for site selections with respect to water use and management; and on possible ways of beneficially utilizing the heat for food production, recreation, or other purposes.

11. Water Demand Considerations. In regions where water supply is unable to keep up with demand, the value of water for specific purposes will increase. Further research is needed on the effect of price on demand with specific attention to the value of water for irrigated agriculture, recreation, industry, urban use and other purposes. Research is also needed to determine appropriate alternative objectives and to develop methods to evaluate benefits in relation to costs for the different objectives, such as, improved distribution of population, environmental quality, and other social values.

#### NMWRRI PRIORITY RESEARCH SUBJECTS

The priority research subjects obtained for this survey were grouped into four categories: Water Quality, Water Quantity, Water Information Dissemination, and Institutional. Inclusion on the list alone indicates concern.

## Water Quality

Community Sewage Treatment Facilities

Evaluation of Septic Tanks vs. Sewage Treatment in Rural and Small Communities

Community Water Supply Systems

Evaluation of methods of improving small community water supplies.

Water Quality Inventories

Base-line water quality inventories of chemical and biological quality of state water supplies.

Sediment Reduction and Control on Watersheds and in Lakes and Reservoirs

Salinity Reduction and Control

Disposal of Brackish (Brine) Water

Evaluation of Economic, Sociological, and Physical Impacts of the Use of Sewage Effluent for Irrigation

Clean Lake Studies because of Federal mandate

Salt Water Intrusion in Ground Water Aquifers, and Evaluation of Salt Accumulations

Irrigation Return Flow Studies

Waste Water Management: Recycling, Irrigation Use, Disposal

Animal Waste Disposal Effects on Water Quality

Drainage Characteristics and Movement of Minerals in Groundwater

Improved Methods of Water Quality Monitoring

Extent and Prevention of Ground and Surface Water Pollution from Tailing Ponds, Mining Operations, and Minerals Processing

Extent, Economic Loss, and Solutions to Problem of Saline Water Gathering in Playas in Oil Producing Areas

Irrigation District Obligations and Relations to the Water Pollution Control Regulations

Assessment of Heavy Metal and Trace Element Contamination of Water

Assessment of Biological Contamination of Water

Evaluation of Agricultural Chemical Use on Water Quality

Evaluation of Extent and Prevention of Thermal Pollution of Water

Evaluation of Septic Tanks vs Sewage Treatment in Highly Populated Areas.

Movement of Chemical Substances in Surface and Groundwater Irrigation Return Flow

Simple Economic Techniques for Water Quality Monitoring

Obligations of Irrigation Systems Operated by Public or Private Organizations or Individuals and Their Relation to Water Pollution Control Regulations

Relation of Erosion and Sedimentation to Salinity in New Mexico Streams

### Water Quantity

Watershed Management and Protection

Watershed Resource Inventories

Vegetative Mapping

Remote Sensing Applications to Watershed Management

Ground Water Resource Inventories

Surface Water Resource Inventories

Agricultural Water Utilization Efficiency

Urban and Rural Domestic, Public, Commercial, and Industrial Water Requirements Inventories

De-Water Studies

Economic (and sociological implications) evaluations of completely depleting a groundwater aquifer in certain time frame.)

Evaporation Suppression Studies

Effects of Urban Uses of Water in Specific Growth Areas as compared to present uses of water

Evaluation of Phreatophyte Removal

Irrigation Systems and Techniques Improvement

Water Supply Alternatives for Municipal Uses

Evapotranspiration Rates of Agricultural Crops, Phreatophytes, and Other Plants, and Base-Line (Bare-Ground)

Irrigation System Design

Improved Methods of Water Quantity Monitoring

Water Infiltration Capacities in Relation to Basin Recharge

Water Evaporation Information

Evaluation of Water Requirements for Energy (Coal Gasification, Electrical Energy, Other)

Water Requirements for Surface Mined Areas Reclamation

Economic Feasibility of Supplemental Irrigation vs. Natural Rainfall for Reclamation and Land Use Conversions

Water in Relation to Land Use and Development

Evaluation of Water Importation Possibilities

Recreational Water Use Demands  
Evaluation of Establishment of Minimum Pools in State Reservoirs  
Evaluation of Water Transportation and Distribution Systems  
Population Growth and Water Supply Relationships  
Evaluation of Irrigation Scheduling, Systems, and Techniques  
Economic, and Sociological Implications of Declining Ground-Water Levels  
Desalting of Water for Agricultural, Municipal, and Other Uses  
Water Supply as It Relates to Land-Use Planning  
Evaluation of Lower Water Using Agricultural Crops  
Development of New Economic Crops with Lower Consumptive Water Use  
Water Conservation and Preservation Techniques  
Evaluation of Irrigation Water Metering  
Feasibility of Improving Ground Water Recharge from Surface Impoundments  
Such as Playa Lakes  
Evaluation of Small Reservoirs for Small Irrigation District, to Reduce  
Flood Runoff and Extend Irrigation Season  
Utilization of Water Metering for Economy and Efficiency of Water Use

#### Water Information Dissemination

Improved Water Information Dissemination Techniques and Programs  
Educational Programs on Water Conservation  
Improved Information Dissemination of Activities and Knowledge of State  
and Federal Agencies  
Coordination of Water Research Activities  
Improving and Updating Knowledge of Hydraulics

#### Institutional

Indian Water-Rights  
Community Water-Rights  
Operation of the Prior Appropriation Doctrine as Applied to Ground Water  
Relationship Between Groundwater Ownership, Use, and Value; to Overlying  
Land Ownership, Use and Value  
Determination of Economic and Social Values of Water Under Various  
Conditions, Projections, Constraints, and Alternatives  
Water Conservation and Preservation vs. Use



Economic, Sociological, Esthetic, and Environmental Implications of  
Maintaining Agricultural Acreage at Present Level

Economic, Sociological, and Esthetic Implications of Maintaining Subsistence  
Agriculture vs. Recreational Use of Water

Implications of Water in Natural Resource Development and Energy Production

Evaluation of and Determination of Recreational Values of Rivers, Lakes,  
and Channels, and Reservoirs

Criteria and Justification of Construction of (Water-Using) Recreational  
Oriented Structures

Environmental Resource Evaluations of River Basins

Flood Plain Evacuation and Relocation and Area Management

Evaluation of the Detrimental Effects of Recreational Use of Areas

Economic Evaluation of Basin Water Allocation Policies

Assessment of National Water Commission Report Implications to State

Economic, Sociological, Environmental, and Esthetic Evaluation of  
Phreatophyte Areas

Recreational Boating Fee Establishment for State Lakes and Reservoirs

Economic, Sociological and Esthetic and Environmental Implications of  
Maintaining Various Leads of Irrigated Agricultural Acreages

U. S. Population Growth and Industry Use of Water.

Gaps in Baseline Environmental Resource Evaluation Information

## NEW MEXICO'S TEN MOST IMPORTANT WATER PROBLEMS

The priority ranking of the previously discussed water problems by state agency officials resulted in the following ten items, in order of importance:

1. Coordination of water research activities.
2. Urban and rural domestic, public, commercial, and industrial water requirements inventories.
3. Improved water information dissemination techniques and programs.
4. Population growth and water supply relationships.
5. Ground water resource inventories.
6. Community water-rights.
7. Improved information dissemination of activities and knowledge by state and federal agencies.
8. Community water supply systems.
9. Economic, sociological, aesthetic, and environmental implications of maintaining agricultural acreage at the present level.
10. Relationship between groundwater ownership, use, and value to overlying land ownership, use, and value.

Some portions of these problems have been and are being studied by researchers within the state and federal agencies, universities, and private organizations. Their presence in these ten, however, indicates a definite need for a more coordinated effort toward their solution. In many cases these problems must be broken down into researchable tasks and project objectives to be handled. However, their solutions must be compatible so that they can be aggregated into an overall solution to the problem.

It was noted in the course of this study that partial solutions to a particular problem are known by some investigators, but are not being applied or further tested for application.

The basic technology, as it is developed by a researcher, ordinarily is in the form of a general solution. In order for this solution to be used in a specific instance, it may need to be somewhat modified and explained. Thus, coordination and cooperation between the researchers and the research users is the key to solving New Mexico's water problems.

## SUMMARY AND CONCLUSIONS

### SUMMARY

The purpose of this study has been to obtain information that will aid in the development of a coordinated program of water resources research in New Mexico. By an inventory and ranking of New Mexico's water problems, an indication of the research needs could be obtained, which hopefully would aid in the coordination of water research projects of greatest importance.

A survey of water-user organizations by mail questionnaire and personal interviews with State, federal, and major water-user organizations officials was conducted. The priority ranking of problem areas and research needs compiled were further ranked by state agency personnel.

### CONCLUSIONS

Research is only one of the many ingredients needed to solve New Mexico's water problems. Technology transfer, basic data, administration and coordination of activities of both the researchers and the research users are also important ingredients. While research report dissemination is necessary, it does not go far enough. A total transfer of the technology (research findings) must be completed before the process is totally successful. The fault does not lie totally with either side, the researcher or the user, but somewhat on both. Better utilization of research findings can be improved by expanded dissemination efforts which span the gap between researcher and user. Traditional research has not been successful in solving day-to-day problems primarily because of the lag in the initiation of research and the time required for the research project. However, these problems could be essentially eliminated if users, capable of forecasting future problems, would encourage research projects prior to a problem reaching the critical stage.

Experience in this study indicates that a high degree of personal contact between water users and administrators on the one hand and researchers and administrators on the other will be required to bridge the gaps. The overwhelming response to this survey by the State, federal, and other organization officials contacted was encouraging.

## REFERENCES

- Banks, H. O., and C. G. Wolfe, *A Plan for A Comprehensive Water Resources Research Information Exchange System*, Leeds, Hill and Jewett, Inc., San Francisco, California, August 1969, 137 pp.
- Elmore, Jr., G. R., *State Organization for Water Resources Management*, School of Civil Engineering and Environmental Resources Center, Georgia Institute of Technology, ERC-0472, Atlanta, May 1972, 143 pp.
- Federal Council for Science and Technology, Committee on Water Resources Research, *A Ten-Year Program of Federal Water Resources Research*, U. S. Government Printing Office, Washington, D. C., February 1966, 88 pp.
- Garner, J. K., and C. S. Shih, *Identification of Water Resources Planning Problems in the Metropolitan Area of Greater San Antonio and its Associated Counties*, Texas Water Resources Institute, TR-49, Texas A & M University, June 1973, 152 pp.
- Geraghty, J. J., D. W. Miller, F. Van der Leeden, and F. L. Troise, *Water Atlas of the United States*, Water Information Center, Port Washington, N. Y., 1973.
- Hill, D. W., and R. L. Meek, *Local Water Agencies, Communication Patterns, and the Planning Process*, Environmental Resources Center, Completion Report Series No. 27, Colorado State University, Fort Collins, Colorado, September 1971, 125 pp.
- Kirkham, D., and N. L. Powell, *Books, Publications, Project Completion Reports, M. S. and Ph.D. Theses Research Supported by Iowa State Water Resources Research Institute*, Ames, June 1970, 68 pp.
- Koenig, D. (Ed.), *The Role and Relevance of University Water Research*, Proceedings of Universities Council on Water Resources Conference, Corvallis, Oregon, August 2-4, 1971, 103 pp.
- Lansford, R. R. and E. F. Sorenson, "Trends in Irrigated Agriculture 1940-1972," *New Mexico Agriculture--1972*, Agricultural Experiment Station Research Report 260, New Mexico State University, Las Cruces, September 1973, pp. 16-17.
- Lansford, R. R., R. D. Latham, and B. J. Creel, "Irrigation Diversions and Depletions," *New Mexico Agriculture--1972*, Agricultural Experiment Station Research Report 260, New Mexico State University, Las Cruces, September 1973, pp. 24-26.
- Martel, R. J., and D. McLaughlin, *Analyzing Organizational Conflicts in Water Resource Management, A Systematic Approach*, The Analytic Sciences Corporation, Reading, Massachusetts, September 1972, 125 pp.

- Minnesota Water Resources Research Center, *Federal, State, and Local Agencies Concerned with Water Resources in Minnesota*, Bulletin 1, University of Minnesota, Minneapolis, December 1969, 122 pp.
- New Mexico State Engineer Office, *Water Resources of New Mexico: Occurrence, Development and Use*, State Planning Office, Santa Fe, 1967, 321 pp.
- Oklahoma Water Resources Research Institute, *Water Resources Research in Oklahoma*, Oklahoma State University, Stillwater, December 1971, 72 pp.
- Reynolds, S. E., *Thirtieth Biennial Report of the State Engineer of New Mexico: 1970-72*, State Engineer Office, Santa Fe, 1973, 119 pp.
- Stewart, J. M., and D. H. Howells, *Perception of Water Resources Research, Dissemination, and Utilization of Research Findings*, Water Resources Research Institute, University of North Carolina, Raleigh, UNC-WRRI-71-58, May 1972, 95 pp.
- Stork, K. E., and N. R. Thomsen, *Water Resources Publications Related to the State of Nebraska, Second Edition*, Water Resources Research Institute, Publication No. 7, University of Nebraska, Lincoln, May 1972, 89 pp.
- Stork, K. E. (Ed.), *Technology Transfer in Water Research: The Interface Between Producers and Users*, Nebraska Water Resources Research Institute, Lincoln, September 1972, 167 pp.
- Stucky, H. R., R. R. Lansford, and B. J. Creel, *Citizens' Conferences on Water 1971*, Water Resources Research Institute, Report No. 11, New Mexico State University, Las Cruces, October 1971, 126 pp.
- U. S. Congress, Senate Select Committee on National Water Resources, *Population Projections and Economic Assumptions*, 86th Cong., 2nd sess., Comm. Print 5, Washington, Government Printing Office, 1961, 49 pp.
- U. S. Congress, "Water Resources Research Act" (78 Stat. 329, 80 Stat. 129, 42 U.S.C. 1961-1961c-7) Public Law 88-379, July 17, 1964.
- U. S. Department of the Interior, Office of Water Resources Research, *Research Reports Supported by Office of Water Resources Research under the Water Resources Research Act of 1964*, FY 1972, Water Resources Scientific Information Center, Washington, D. C., 204 pp.
- U. S. Department of the Interior, Office of Water Resources Research, *Cooperative Water Research and Training--1972 Annual Report*, Washington, D. C., 1973.
- U. S. Department of the Interior, Office of Water Resources Research, "Rules and Regulations Pursuant to the Water Resources Research Act of 1964 (P.L. 88-379)" Published in Federal Register (U. S. Government Printing Office): title 18, Chapter IV, Revised January 1, 1973.
- U. S. Water Resources Council, *The Nation's Water Resources--Summary Report (Part 1)*, U. S. Government Printing Office, Washington, D. C., 1968, 30 pp.

U. S. Water Resources Council, *The Nation's Water Resources (Parts 1-7)*, U. S. Government Printing Office, Washington, D. C., 1968, 417 pp.

Viessman, W., Jr., *A User-Oriented Water Research Plan for Nebraska*, Water Resources Research Institute, University of Nebraska, Lincoln, Publication No. 8, April 1972, 54 pp.

Walker, W. R., *Water Resources Research in Virginia*, Water Resources Research Center Bulletin 18, Virginia Polytechnic Institute, Blacksburg, Virginia, September 1968, 50 pp.

Walker, W. R., *Water Resources Research Interests in the Colleges and Universities of Virginia*, Water Resources Research Center Bulletin 17, Virginia Polytechnic Institute, Blacksburg, Virginia, September 1968, 49 pp.

Willeke, G. E., A. C. Benke, A. M. Lamb, B. H. Kornegay, and W. P. Neely, *Georgia's Water Problems and Related Research Needs*, Environmental Resources Center, Georgia Institute of Technology, Atlanta, Georgia, ERC-1173, August 1973, 100 pp.

Wisconsin Water Resources Center, *Publications, Reports, and Theses Resulting from Research Sponsored by the Wisconsin Water Resources Center, 1965-1971*, University of Wisconsin, Madison, May 1972, 67 pp.

APPENDIX--A  
RESEARCH PROJECTS

Table A-1. TITLE I SECTION 100 (ANNUAL ALLOTMENT) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

Project Number <sup>a</sup>	FCST Category <sup>b</sup>	Project Funded										Project Title and Principal Investigator	
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974		
A-001	2A	x	x	x								Synthetic hydrology	-Hernandez
A-002	5A	x	x	x								Gas chromatographic evaluation of bacterial stream pollution	-Garner
A-003	5C	x	x	x	x		p	n				A study of the effects of water quality and environmental factors affecting fresh water vertebrates	-Whitford
A-004	2G	x	x	x	x							The effects of soil properties on the retention, percolation and run-off of precipitation	-Anderson
A-005	3C	x	x	x								Plant composition and soil properties as affected by irrigation water quality	-Dregne
A-006	3F	x	x	x	x	x	p	n				The effect of irrigation method and moisture and fertility levels upon maximizing water use efficiency and quality cotton fiber production	-Williams
A-007	6D	x	x									Inventory of irrigation areas and determination of consumptive uses by areas	-Henderson
A-008	4B	x	x	x	x		p	n				Hydrogeology of the lower Rio Grande Valley and adjacent intermontane areas of New Mexico	-King
A-009	6D	x	x									Economics of alternative pricing systems to allocate scarce water supplies	-Long
A-010	5D	x	x	x	x		p	n				A comparison of the aquatic beetles in the five major watersheds of New Mexico with special emphasis on the family Dytiscidae	-Zimmerman
A-011	5D			x								U-tube aeration	-Speece
A-012	6E			x	x	x						History of water utilization in the southwest, with particular reference to New Mexico	-Clark
A-013	5D				x							Nitrogen removal from natural waters	-Speece
A-014	2F				x							Fluctuations in water droplet evaporation rates	-Bryant
A-015	3A				x							Solar heating of water to very high temperatures	-Cobble
A-016	2G						x	x	x	c		Model study to predict salt distribution and concentration of water in soil profiles	-Alfaro
A-017	6A					x	x	n				Decision models for minimizing the cost of information or error in estimating benefit-water relationships with special applications to irrigation	-d'Arge
A-018	5F					x	x	n				Feasibility of treating and recycling used fish hatchery water	-Speece
A-019	2H					x	x	x	n			Comparative productivities of small bodies of water in desert and montane areas of southern New Mexico	-Whitford
A-020	5D					x	p	n				Development of a froth process for the treatment of sour water	-Wilson
A-021	5C						x	x	n			An investigation of primary productivity and an analysis of nutrients in Elephant Butte Reservoir using the <sup>14</sup> C method	-Johnson
A-022	6D						x	n				Applying linear programming models for estimating the agricultural demand function for water	-Gieser
A-023	1B						x	p				An NMR and calorimetric study of the interactions between lanthanide ions and water	-Birnbaum



Table A-1. TITLE I SECTION 100 (ANNUAL ALLOTMENT) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE (Cont'd.)

Project Number	FCST Category	Project Funded										Project Title and Principal Investigator	
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974		
A-024	2D						x	x	x	n		Cloud chamber study of water evaporation	-Good
A-025	6D							x	x			Estimation of capital-water elasticities of substitution	-Brown
A-026	6E							x	x	n		The impact of water technology on the history of New Mexico	-Christiansen
A-027	3B							x	c			Utilization of rain water in a semiarid region	-Fuehring
A-028	4B							x	n			Simulation of coupled leaky aquifers and a surface-water system	-Saleem
A-029	5C							x	x	n		Bioassays of quality in water resources of major importance to New Mexico	-Smith
A-030	5B							x	p			Environmental controls on groundwater chemistry in New Mexico: The effect of phreatophytes	-Titus
A-031	9A								x	n		The development and field testing of school learning materials on water problems of New Mexico and the southwest	-Buethe
A-032	5G								x	n		A feasibility study of thermal pollution abatement by adiabatic degassing	-Wilson
A-033	5F								x	n		A method of demineralization using strongly basic ion exchange resins	-Midkiff
A-034	5A								x	p		Pollution studies of the regional Ogallala aquifer at Portales, New Mexico	-Taylor
A-035	5D								x	n		Study phosphate induced algal growth in order to suppress or eliminate this phenomena	-Patterson
A-036	6D								x	n		Inventory of water diversions and rate structure for cities, towns, and villages in New Mexico	-Randall
A-037	5B								x	n		Tritium as a tool in the determination of hydrologic parameters in the Roswell Basin	-Gross
A-038	5C									x	c	A study of the chemical and biological character of Rio Grande water in the Bosque Del Apache	-Popp
A-039	5C									x	n	Hydrologic-nutrient cycle interactions in undisturbed and man-manipulated ecosystems (Watersheds)	-Gosz
A-040	5C									x	n	An investigation of primary productivity and an analysis of nutrients in Elephant Butte Reservoir using the <sup>14</sup> C method	-Johnson, Kidd
A-041	6E									x	p	Water Resource problems and research needs of New Mexico	-Creel
A-042	2P									x	c	Measurement of groundwater flow using an in-situ thermal probe	-Sanford, Reiter
A-043	3P									x		Predicting consumptive use with climatological data	-Hanson
A-044	2F									x		Experimental calibration and field test for a thermal probe for in-situ groundwater flow measurements	-Sanford, Reiter
A-045	6A									x		Analysis of alternative futures of the Rio Grande Region in New Mexico	-Lansford
A-046	5B									x		The determination of content and origin of lead in surface and ground waters of northeastern New Mexico	-Haestas

Table A-1. TITLE I SECTION 100 (ANNUAL ALLOTMENT) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE (Cont'd.)

Project Number	FCST Category	Project Funded								Project Title and Principal Investigator			
		1965	1966	1967	1968	1969	1970	1971	1972		1973	1974	
A-047	5D										x	Time parameter in the mechanism of flocculation	-Barkley
A-048	5B										x	Calcium carbonate equilibria in soils and irrigation waters	-O'Connor

- <sup>a</sup> The prefix "a" identifies a project supported by Sec. 100 (Annual Allotment) funds.
- <sup>b</sup> The prefix "b" identifies a project supported by Sec. 101 (Matching Grant) funds.
- <sup>p</sup> Funded in prior fiscal year - work in progress.
- <sup>n</sup> No fiscal year fund support - completion report in preparation.
- <sup>c</sup> Project completion report received by OWRR during fiscal year.
- <sup>x</sup> Project approved for fiscal year fund support.

Table A-2. TITLE I SECTION 101 (MATCHING GRANT) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

Project Number	FCST Category	Project Funded										Project Title and Principal Investigator		
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974			
B-001	6D		x	x	x								Recreational values of water in major reservoirs of New Mexico	-Gray
B-002	6B		x	x									Appraisal of some of the factors adding to or detracting from the socio-economic use of New Mexico's thermal waters	-Bertholf, Summers
B-003	6B		x	x									Reconnaissance study of the Pecos River Basin, New Mexico	
B-005	3B			x	x			p	n				Geohydrologic factors affecting rate of evaporation from moist playas	-Titus
B-006	6A			x	x			p	p	p			A comprehensive water resources analysis of a typical overdrawn basin in an irrigated semiarid area--Pecos River Basin, New Mexico	-Stucky, Jacobs, Wollman, and Hernandez
B-007	6D				x			p	n				Determination of sensitivity of United States water demand-supply models to specified changes in conditions	-Wollman
B-008	6D				x	x		p	n				Irrigable acreage in New Mexico and projected demands for irrigation water	-Hanson, Henderson
B-011	6A					x		p	p	p			A comprehensive water resources analysis of a typical overdrawn basin in an irrigated semiarid area--Pecos River Basin, New Mexico	-Stucky
B-012	6E					x		p	n				Patterns of policy making in water development	-Ingram
B-013	3A					x		p	n				A comprehensive analysis of the Tularosa Basin saline water Resources--their availability and potential economic development	-Kittlowski, Summers, Titus
B-014	6B					x		p	n				Irrigability classification of New Mexico soils as a guide for water importation	-Anderson
B-015	6B							x	p	p	p	n	Irrigability classification of New Mexico soils as a guide for water importation	-Anderson
B-016	6B							x	p	p	n		An analytical interdisciplinary evaluation of the utilization of the water resources of Rio Grande in New Mexico	-Hernandez
B-017	6D							x	p	n			Estimation of capital water elasticities of substitution in U. S. Manufacturing	-d'Arge, Falkson
B-019	6B								x	p	n		An analytical interdisciplinary evaluation of the utilization of the water resources of the Rio Grande in New Mexico, Phase II	-Hernandez
B-021	2D								x	p	n	c	A comparison of rates of water loss through transpiration of several southern New Mexico Phreatophyte species	-Cunningham
B-025	3F								x	p	n		Management of replacement flows in Agricultural areas	-Gisser
B-026	6B									x	p		An analytical interdisciplinary evaluation of the utilization of the water resources of the Rio Grande in New Mexico, Phase II	-Lansford
B-027	2D									x	p	c	A comparison of rates of water loss, through transpiration of several southern New Mexico Phreatophyte species, Phase II	-Cunningham

Table A-2. TITLE I SECTION 101 (MATCHING GRANT) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE (Cont'd.)

Project Number <sup>a</sup>	Category <sup>b</sup>	Project Funded							Project Title and Principal Investigator				
		1965	1966	1967	1968	1969	1970	1971					
B-029	3F							x	p	p	Utilization of water in a semiarid region	-Fuehring	
B-032	3E							x	p	p	Analysis of water characteristics of manufacturing industries and their adaptability to semiarid regions	-Ben-David, Arnwine	
B-037	6A									x	p	An interdisciplinary analysis of the water resources of the High Plains of New Mexico	-Lansford
B-038	2K									x	p	Aquifer parameters by a chemical tracer technique	-Mercado
B-040	4C										x	Water use and urban development in the Albuquerque, New Mexico, S.M.S.A.: A study of user practices, attitudes, and priorities	-Lupsha
B-041	2F										x	Application of environmental tritium in the measurement of recharge and aquifer parameters in a semi-arid limestone terrain	-Rabinowitz, Gross

<sup>a</sup> The prefix "a" identifies a project supported by Sec. 100 (Annual Allotment) funds.

<sup>b</sup> The prefix "b" identifies a project supported by Sec. 101 (Matching Grant) funds.

<sup>p</sup> Funded in prior fiscal year - work in progress.

<sup>n</sup> No fiscal year fund support - completion report in preparation.

<sup>c</sup> Project completion report received by OWRR during fiscal year.

<sup>x</sup> Project approved for fiscal year fund support.

Table A-3. TITLE II (OTHER RESEARCH) PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

Project Number	FCST Category	Project Funded										Project Title and Principal Investigator		
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974			
C-1361	5G				x		c						Soil and water management for salinity control	-Stucky
C-1630	3C							x	o	c			Soil and water management for salinity control, Phase II	-Wierenga
C-2165	5G								x	o	x	o	Soil and water management for salinity control, Phase III	-Wierenga
C-4060	3D										x	o	Reduction of peak water consumption in urban areas	-Cotter

<sup>a</sup> The prefix "a" identifies a project supported by Sec. 100 (Annual Allotment) funds.

<sup>b</sup> The prefix "b" identifies a project supported by Sec. 101 (Matching Grant) funds.

<sup>o</sup> The prefix "o" identifies a project supported by other funds.

<sup>c</sup> Project completion report received by OWRR during fiscal year.

<sup>x</sup> Project approved for fiscal year fund support.

Table A-5. OTHER PROJECTS, NMRRI

Project Number	FCST Category	Project Funded										Project Title and Principal Investigator		
		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974			
0-302	uc							x		c			Citizens conference on water	-Stucky
0-304	uc					x							An analysis of the saline water resources of the Tularosa Basin	-Stucky, King, Titus
0-305	uc					x	x	x	x				Research of the possibilities of biological control of Tamarisk and other phreatophytes	-Watts, Haier
0-306	uc		x	x	x	c							Water requirements for crop production in the Roswell underground water basin	-Stucky
0-308	uc								x	x	x	x	Quality and quantity of return flow as influenced by trickle and surface irrigation	-Clark, Wierenga, Patterson, Hanson, Baltensperger, O'Connor

<sup>c</sup> Project completion report received by OWRR during fiscal year.

<sup>x</sup> Project approved for fiscal year fund support.

<sup>uc</sup> Unclassified.

Table A-4. STATE SUPPORTED PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

Project Number	FCST Category	Project Funded								Project Title and Principal Investigator			
		1965	1966	1967	1968	1969	1970	1971	1972			1973	1974
S-114	uc							x	n	c	Tritium as a tool in the determination of hydrologic parameters in the Roswell Basin	-Gross	
S-115	uc							x	x		History of water utilization in New Mexico and the southwest--with particular referencd to the impact of legal and institutional controls on water management	-Clark	
S-116								x	c		Bioassays of quality in water resources of major importance to New Mexico	-Smith	
S-121								x	n	n	Environmental controls on groundwater chemistry in New Mexico: I. The affect of phreatophytes	-Titus	
S-122								x	x	c	A study of the chemical and biological character of Rio Granda water in the Bosque Del Apache refuge	-Brandvold, Brierley, Popp	
S-123								x	x	n	c	Analysis of Mercurials in Elephant Butte Reservoir	-Garcia, Kidd, Johnson
S-124								x	n	c	Measurement of groundwater flow using an in-situ thermal probe	-Reiter, Sanford	
S-125								x	n	c	Water as a limiting factor in indian economic development	-Ben-David, Borrego, Brown	
S-126								x	p	c	Hydrologic- nutrient cycle interactions in undisturbed and man-manipulated ecosystems (watersheds)	-Goss	
S-127								x	c		Tritium as a tool in the determination of hydrologic parameters in the Roswell Basin	-Gross	
S-128								x	c		Bioassays of quality in water resources of major importance to New Mexico	-Smith	
S-129								x	p	c	Inventory of water diversions and rate structure for cities, towns, and villages in New Mexico	-Randall	
S-130								x			Cropland uses and agricultural water depletions in New Mexico	-Lansford	
S-131								x			An analysis of amounts of lead and their origin in surface and ground waters in northeastern New Mexico	-Maestas	
S-133										x	Preliminary evaluation of Professor C. E. Jacob's contributions in the field of water resources in New Mexico	-Brutsuert	
S-134										x	Cropland uses and agricultural water depletions in New Mexico	-Lansford, Creol	
S-135										x	p	The determination of content and origin of lead in surface and ground waters in northesstern New Mexico	-Maestas
S-136										x	x	Predicting the quality of irrigation return flow	-Wierenga
S-137										x	n	Environmental controls on groundwater chemistry in New Mexico: I. The effects of phreatophytes	-Titus
S-138										x	c	The impact of water technology on the history of New Mexico	-Christiansen
S-141										x	n	Irrigation returns and residence time of recharge by a tracer technique	-Rabinowitz, Gross

Table A-4. STATE SUPPORTED PROJECTS, NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE (Cont'd.)

Project Number <sup>a</sup>	FCST Cate- gory	Project Funded								Project Title and Principal Investigator		
		1965	1966	1967	1968	1969	1970	1971	1972		1973	1974
S-144										x	Calcium carbonate equilibria in soils and irrigation waters	-O'Connor
S-145										x	The impact of water quality standards on water utilization in the Rio Grande Basin of New Mexico	-Ben-David, Brutsaert
S-146										x	Stream organics to evaluate land management	-Gosz, Barr
S-147										x	Sources of groundwater contamination in the Ogallala aquifer in eastern New Mexico	-Taylor, Russell
S-150										x	A contribution of natural tritium studies to water resource management in the Roswell Basin, New Mexico	-Rabinowitz

\* The prefix "a" identifies a project supported by Sec. 100 (Annual Allotment) funds.

<sup>P</sup> Funded in prior fiscal year - work in progress.

<sup>n</sup> No fiscal year fund support - completion report in preparation.

<sup>c</sup> Project completion report received by OWRR during fiscal year.

<sup>x</sup> Project approved for fiscal year fund support.

APPENDIX--B

WATER RESOURCES RESEARCH INSTITUTE PUBLICATIONS LIST

The Office of Water Resources Research, U. S. Department of Interior, under authorization of the Water Resources Research Act of 1964 (P.L. 88-379), was the major source of support for the research accomplished through Annual Allotment, Matching Grant, and Title II projects. State sources and contracts with local, state, and federal agencies provided additional research support. The research reported here was conducted in over twenty-five academic and research departments through their established administrative units at New Mexico State University, University of New Mexico, Institute of Mining and Technology, and Eastern New Mexico University. A current project is underway at Highlands University.

The publications listed below were published by the New Mexico State Water Resources Research Institute or by cooperating agencies. Those with \* preceding the listing are out of print. Questions concerning specific publications may be directed to the WRRRI or to the principal investigators.



1964

\*Viessman, Warren Jr., *A Compilation of Water Resources Research Projects at New Mexico State University*, Engineering Experiment Station, New Mexico State University, Technical Report No. 17, 1964, 14 pp.

\_\_\_\_\_, *The Hydrology of Small Impervious Areas*, Engineering Experiment Station, New Mexico State University, Technical Report No. 24, 24 pp.

1965

\*Garner, William and R. N. Gennaro, "Gas Chromatographic Differentiation of Closely Related Species of Micro-organisms," *American Chemical Society Abstracts*, Vol. 150, p. 11Q (abstract).

\*Gennaro, Robert N., *Application of Gas Chromatography to Microbiology: I. Application of the Golay Column to Improved Resolution of Pyrolysates; II. Characterization of Six Species of the Family Enterbacteriaceae by Gas Chromatography*, Unpublished Master's Thesis, Department of Sanitary Science, New Mexico State University, 68 pp.

1966

\*Chen, David Y., *A Proposed Pricing System for Ground Water Allocation in the Portales Valley of New Mexico*, Unpublished Master's Thesis, Agricultural Economics Department, New Mexico State University.

\*Henderson, Donald C., and H. R. Stucky, *Agricultural Land and Water in New Mexico*, State Planning Office, Santa Fe, 62 pp.

Hernandez, John W., *A Compilation of Water Resources Research and Graduate Training Activities at New Mexico State University*, New Mexico State University, WRRRI Publications No. 1, 1966, 72 pp.

\_\_\_\_\_, and Thomas J. Eaton, *A Bibliography Pertaining to the Pecos River Basin in New Mexico*, New Mexico State University, WRRRI Publications No. 2, 50 pp.

\_\_\_\_\_, and Ahmen Yousef Abdel-Razaq, *A Numerical Solution of the Equations of Motion as Applied to Surface Flow*, Engineering Experiment Station, New Mexico State University, Technical Report No. 36, 89 pp.

Speece, R. R., and J. L. Adams, *U-Tube Aeration*, Engineering Experiment Station, New Mexico State University, Technical Report No. 38, 77 pp.

\*Summers, W. K., "Distribution and Occurrence of New Mexico's Thermal Waters--A Statistical Summary," *New Mexico Geological Society Guidebook, 17th Field Conference*, p. 122 (abstract).

1967

\*Bailey, Oran F., *Water Availability and Grass Root Distribution in Selected Soils*, Unpublished Master's Thesis, Department of Agronomy, New Mexico State University.

\*Boswell, Thomas Oliver, *The Effects of Water Hardness on the Upper Lethal Temperature of the Green Sunfish (Lepomis Cyanellus)*, Unpublished Master's Thesis, Biology Department, New Mexico State University, 31 pp.

Garnett, Edwin T., Robert R. Lansford, and Gene Ott, *Cotton Costs and Returns Under Ditch Irrigation in De Baca County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-203, 2 pp.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, *Vega Hay Costs and Returns in Upper Pecos River Basin*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-301, 2 pp.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, *Alfalfa Costs and Returns in the Upper Pecos River Basin*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-302, 3 pp.

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, *Corn Costs and Returns in the Upper Pecos River Basin*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-407, 2 pp.

Hantush, M. S., "Growth and Decay of Ground Water Mounds in Response to Uniform Percolation," *Water Resources Research*, Vol. 3, No. 1, New Mexico Institute of Mining and Technology, pp. 227-234 (reprint).

\_\_\_\_\_, "Depletion of Flow in Right-Angle Stream Bends by Steady Wells," *Water Resources Research*, Vol. 3, No. 1, New Mexico Institute of Mining and Technology, pp. 235-240 (reprint).

\_\_\_\_\_, "Flow of Ground Water in Relatively Thick Leaky Aquifers," *Water Resources Research*, Vol. 3, No. 2, New Mexico Institute of Mining and Technology, pp. 583-590 (reprint).

\_\_\_\_\_, "Flow to Wells in Aquifers Separated by a Semipervious Layer," New Mexico Institute of Mining and Technology, *Journal of Geophysical Research*, Vol. 72, No. 6, pp. 1709-1720 (reprint).

\*Myers, William R., *A Study of Three Regimes of Orifice Flow in One-Half Inch Diameter Polyethylene Plastic Tubing*, Unpublished Master's Thesis, Agricultural Engineering Department, New Mexico State University.

Speece, R. E., and Robert Montgomery, *Nitrogen Removal from Natural Waters*, Engineering Experimental Station, New Mexico State University, Technical Report No. 48, 71 pp.

\*Spiegel, Zane, *Fundamental Concepts of Geohydrology Applied to the Pecos Valley and Related Aquifer Systems*, State Engineer Office, 47 pp.

\*Summers, W. K., "A Comparison of Long Term and Short Term Pumping Tests," New Mexico Institute of Mining and Technology, *Groundwater*, Vol. 5, No. 3

\*Taylor, Andrew M., 1967, *Geohydrologic Investigations in the Mesilla Valley, New Mexico*, Unpublished Master's Thesis, Earth Science Department, New Mexico State University, 130 pp.

1968

Anderson, J. U., A. E. Stewart, and P. C. Gregory, *A Portable Rainfall Simulator and Runoff Sampler*, Agricultural Experiment Station, New Mexico State University; Research Report No. 143, 8 pp.

\*Clark, Ira G., *Administration of Water Resources in New Mexico*, New Mexico State University, WRRI Research Report No. 3, 32 pp.

Coppedge, R. O., and J. R. Gray, *Recreational Use and Value of Water at Elephant Butte and Navajo Reservoirs*, Agricultural Experiment Station, New Mexico State University, Bulletin No. 535, 24 pp.

\*d'Arge, Ralph, *Quantitative Water Resource Basin Planning--An Analysis of the Pecos River Basin, New Mexico*, Department of Economics, University of New Mexico, Technical Research Report (unnumbered), 147 pp.

Dregne, H. E., and J. U. Anderson, *Irrigable Land in Curry County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 140.

\*Garnett Edwin, T., *Economic Classification of the Irrigated Cropland in the Roswell Artesian Basin, New Mexico*, Unpublished Master's Thesis, Department of Agricultural Economics, New Mexico State University, 171 pp.

\_\_\_\_\_, Robert R. Lansford, and Gene Ott, *Irrigated Bermudagrass Pasture Costs and Returns in De Baca County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-303, 3 pp.

\_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Alfalfa Costs and Returns Under Pump Irrigation in De Baca County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-304, 3 pp.

\_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Alfalfa Costs and Returns Under Surface Irrigation in De Baca County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-305, 3 pp.

- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Irrigated Pasture Costs and Returns in the Upper Pecos River Basin*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 A-306, 3 pp.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Chile Costs and Returns in the Upper Pecos River Basin*, Agricultural Extension Service, New Mexico State University, Plant Science Guide 400 H-205, 2 pp.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Alfalfa Costs and Returns Under Ditch Irrigation in Quay County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide No. 400 A-307, 3 pp.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Irrigated Forage Sorghum Costs and Returns in Union County*, Agricultural Extension Service, New Mexico State University, Plant Science Guide No. 400 A-308, 2 pp.
- Havenor, Kay D., *CPG Structure, Stratigraphy, and Hydrogeology of Northern Roswell Artesian Basin, Chaves County, New Mexico*, New Mexico Institute of Mining and Technology, Circular 93, 30 pp.
- Henderson, D. C., and Earl F. Sorenson, *Consumptive Irrigation Requirements of Selected Irrigation Areas in New Mexico*, Agricultural Experiment Station, New Mexico State University, Bulletin No. 531, 55 pp.
- \*Hughes, William C., *Economic Feasibility of Increasing Pecos Basin Water Supplies Through Reduction of Evaporation and Evapo-Transpiration*, Department of Economics, University of New Mexico, Technical Research Report, 80 pp.
- Maker, H. J., and H. E. Dregne, *Land Resource Areas of New Mexico*, Agricultural Experiment Station, New Mexico State University, Research Report No. 147, 30 pp.
- Mojallali, Hessam, and H. E. Dregne, *Relation of Soil Hydraulic Conductivity to Exchangeable Cations Salinity*, Agricultural Experiment Station, New Mexico State University, Bulletin No. 540, 11 pp.
- \*Pellette, P., M. Cobble and P. Smith, "Honeycomb Thermal Trap," Mechanical Engineering Department, New Mexico State University, *Pergamon Press*, (Great Britain) Vol. 12, pp. 263-265, (reprint).
- \*Ro, Pyung Syk, T. S. Fahlen and H. C. Bryant, "Precision Measurements of Water Droplet Evaporation Rates," *Applied Optics*, Vol. 7, No. 5, p. 8, (reprint).
- \*Simkins, Arthur R., *An Economic Analysis of Irrigation Water Requirements for Crop Production in the Roswell Artesian Basin, New Mexico*, Unpublished Master's Thesis, Department of Agricultural Economics, New Mexico State University, 305 pp.
- Speece, R. E., *Nitrogen Removal from Natural Waters*, Engineering Experiment Station, New Mexico State University, Technical Report 48, 71 pp.

1969

Anderson, J. U., and H. E. Dregne, *Irrigable Land in Roosevelt County, Agricultural Experiment Station, New Mexico State University, Research Report No. 155, 12 pp.*

\*Anderson, J. V., P. S. Derr, and O. F. Bailey, "The Use of a Rainfall Simulator to Study Soil Water Relationships in Semi-arid Rangeland," (abstract published in the Proceeding of the International Arid Lands Conference, June 1969).

\*Barnes, Carl E., *Irrigation Water Requirements for Crop Production: Roswell Artesian Basin--An Agronomic Analysis and Basic Data, New Mexico State University, WRRRI Report 4 Part I, 121 pp.*

\*Carroon, Evan, and E. G. Hanson, *Irrigation Water Requirements for Crop Production: Roswell Artesian Basin--An Engineering Analysis and Basic Data, New Mexico State University, WRRRI Report No. 4 Part 3, 56 pp.*

Dregne, H. E., *Irrigation Water Quality and the Leaching Requirement, Agricultural Experiment Station, New Mexico State University, Bulletin No. 542, 17 pp.*

Dregne, H. E., *Prediction of Crop Yields from Quantity and Salinity of Irrigation Water, Agricultural Experiment Station, New Mexico State University, Bulletin No. 543, 16 pp.*

\*Hassen, Timothy A., *The Development of a Conservation Policy for the Unreserved Public Lands 1924-34, Unpublished Master's Thesis, Department of History, New Mexico State University, 131 pp.*

Ingram, Helen M., *Patterns of Politics in Water Resources Development: A Case Study of New Mexico's Role in the Colorado River Basin Bill, Division of Government Research, University of New Mexico, Publication No. 79, 96 pp.*

\*Jones, Frank H., *Prediction of Orifice Discharge and Head Loss Along a Small Diameter Terminal Perforated Pipe, Unpublished Master's Thesis, Department of Civil Engineering, New Mexico State University, 45 pp.*

\*King, W. E., J. W. Hawley, A. M. Taylor, and R. P. Wilson, *Hydrogeology of the Rio Grande Valley and Adjacent Intermontane Areas of Southern New Mexico, New Mexico State University, WRRRI Report No. 6, 141 pp.*

Lansford, R. R., and Bobby J. Creel, *Irrigation Water Requirements for Crop Production: Roswell Artesian Basin--An Economic Analysis and Basic Data, New Mexico State University, WRRRI Report No. 4 Part 2, 275 pp.*

\_\_\_\_\_, Carl E. Barnes, Bobby J. Creel, Eldon C. Hanson, Harold E. Dregne, Evan Carroon, and H. R. Stucky, *Irrigation Water Requirements for Crop Production: Roswell Artesian Basin--Project Analysis and Summary, New Mexico State University, WRRRI Report No. 4 Part 4, 116 pp.*

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Irrigation Water Requirements for Crop Production: Roswell Artesian Basin, New Mexico, New Mexico State University, WRRRI Report No. 5, 59 pp.*

Maker, H. J., C. W. Keetch, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, San Juan County*, Agricultural Experiment Station, New Mexico State University, Research Report 161, 40 pp.

\_\_\_\_\_, H. E. Dregne, and J. U. Anderson, *Land Classification for Irrigation, Curry County*, Agricultural Experiment Station, Research Report No. 162, 8 pp.

Speece, R. E., and W. E. Leyendecker, *Fish Tolerance to Dissolved Nitrogen*, Engineering Experiment Station, New Mexico State University, Technical Report No. 59, 44 pp.

\*Summers, W. K., and Frank E. Kottowski (Editors), *The San Andres Limestone Reservoir for Oil and Water in New Mexico*, New Mexico Geological Society, Hobbs, New Mexico, Symposium Special Publication No. 3, 51 pp.

\*Titus, Frank B., *Late Tertiary and Quaternary Hydrogeology of Estancia Basin, Central New Mexico*, Ph.D. Dissertation, Department of Geology, University of New Mexico, 179 pp.

#### 1970

\*Alfaro, Jose F., *Model Study to Predict Salt Distribution and Concentration of Water in Soil Profiles*, New Mexico State University, WRRRI Project Completion Report A-016-NMEX, 14 pp.

Anderson, James U., *Soils of the San Juan Branch Agricultural Experiment Station*, Agricultural Experiment Station, New Mexico State University, Research Report No. 180, 16 pp.

\_\_\_\_\_, H. E. Dregne, and H. J. Maker, *Land Classification for Irrigation, Roosevelt County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 163, 12 pp.

Burkstaller, John, and R. E. Speece, *Survey of Treatment and Recycle of Used Fish Hatchery Water*, Engineering Experiment Station, New Mexico State University, Technical Report No. 64, 41 pp.

d'Arge, R. C., *Quantitative Water Resource Basin Planning: An Analysis of the Pecos River Basin, New Mexico*, New Mexico State University, WRRRI Report No. 8, 104 pp.

Hughes, William C., *Economic Feasibility of Increasing Pecos Basin Water Supplies Through Reduction of Evaporation and Evapo-transpiration*, New Mexico State University, WRRRI Research Report No. 9, 38 pp.

\*Imara, Numa, *One Dimensional Dispersion in Steady-Nonuniform Flows*, Ph.D. Dissertation, Department of Civil Engineering, New Mexico State University, 172 pp.

- \_\_\_\_\_, and T. G. Gebhard Jr., *One Dimensional Dispersion in Steady-Nonuniform Flows*, Engineering Experiment Station, New Mexico State University, Report No. 69, 172 pp.
- Lansford, R. R., E. T. Garnett, and B. J. Creel, *An Economic Land Classification of the Irrigated Cropland in the Pecos River Basin, New Mexico*, New Mexico State University, WRI Report No. 7, 56 pp.
- Maker, H. J., D. N. Cox, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Hidalgo County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 177, 29 pp.
- \_\_\_\_\_, V. G. Link, and \_\_\_\_\_, *Soil Associations and Land Classification for Irrigation, Eddy County*, Agricultural Experiment Station, New Mexico State University, Research Report 170, 34 pp.
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *Soil Associations and Land Classification for Irrigation, Lea County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 178, 40 pp.
- \_\_\_\_\_, D. S. Pease, and \_\_\_\_\_, *Soil Associations and Land Classification for Irrigation, Harding County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 165, 33 pp.
- \_\_\_\_\_, O. F. Bailey, and \_\_\_\_\_, *Soil Associations and Land Classification for Irrigation, Luna County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 176, 31 pp.
- Saleem, Z. A., "A Computer Method for Pumping-Test Analysis," *Ground Water*, New Mexico Institute of Mining and Technology, Vol. 8, No. 5, 4 pp. (reprint).
- Speece, R. E., and Richard P. Gigger Jr., *Treatment of Fish Hatchery Effluent for Recycle*, Engineering Experiment Station, New Mexico State University, Technical Report No. 67, 119 pp.
- \*Wilkins, David W., *A Laboratory Method for Predicting Effluent Concentrations Using Soil Profile Models*, Unpublished Master's Thesis, Department of Civil Engineering, New Mexico State University, 78 pp.
- \*Wilson, Donald B., *Development of a Froth Process for the Treatment of Sour Water*, New Mexico State University, WRI Final Report, Project No. A-020-NMEX-3109-31, 30 pp.

1971

- \*Alfaro, J. F., "Application of Physical Model Theory to Predict Salt Displacement on Soils," *Soil Science*, Vol. 112, No. 5, pp. 364-372 (reprint).

- Creel, Bobby J., "Monthly Consumptive Irrigation Requirements as a Guide to Efficient Management," *Proceedings of the Sixteenth Annual New Mexico Water Conference*, New Mexico State University, WRRI, pp. 130-138.
- \* \_\_\_\_\_, *An Economic Classification of the Irrigated Cropland in the Lower Rio Grande Basin, New Mexico*, Unpublished Master's Thesis, Department of Agricultural Economics, New Mexico State University, 137 pp.
- \*d'Arge, R. C., *Decision Models for Minimizing the Cost Information on Error in Estimating Benefit-Water Relationships with Special Applications to Irrigation*, New Mexico State University, WRRI, Partial Technical Completion Report A-017-NMEX, 22 pp.
- \*DeBrine, B. E., *Quantitative Hydrologic Study of a Closed Basin with a Playa (Estancia Valley, New Mexico)*, Unpublished Master's Thesis, Department of Geoscience, New Mexico Institute of Mining and Technology.
- \*Dodge, Carl E., *Cloud Chamber Design for Water Evaporation Studies*, Master's Thesis, Department of Physics, New Mexico State University.
- \*Grieve, R. E., *Development and Use of a Method for Assessing Leaf Surface Areas in Phreatophyte Communities*, Unpublished Master's Thesis, Biology Department, New Mexico State University, 31 pp.
- \*Haley, Eugene V., *A Computer Program for the Calculation of Consumptive Irrigation Requirements Utilizing the Blaney-Criddle Method*, Unpublished Special Problem Paper, Department of Agricultural Economics, New Mexico State University.
- Hernandez, John W., *Management Alternatives in the Use of the Water Resources of the Pecos River Basin in New Mexico*, New Mexico State University, WRRI Report No. 12, 196 pp.
- \*Hernes, Gary L., and W. K. Summers, *Plotwells, Part I. User's Manual*, New Mexico Institute of Mining and Technology.
- \* \_\_\_\_\_, and \_\_\_\_\_, *Plotwells, Part II. Program Plus Input and Output Data*, New Mexico Institute of Mining and Technology.
- King, W. E., J. W. Hawley, A. M. Taylor, and R. P. Wilson, *Geology and Ground-water Resources of Central and Western Dona Ana County, New Mexico*, New Mexico State Bureau of Mines and Mineral Resources Hydrologic Report No. 1, New Mexico Institute of Mining and Technology, 64 pp.
- Lansford, Robert R., and B. J. Creel, "Cost of Producing Selected Field Crops in the Rio Grande Basin, New Mexico, 1970," *New Mexico Agriculture--1970*, Agricultural Experiment Station, New Mexico State University, Research Report 195.
- \_\_\_\_\_, and \_\_\_\_\_, "Irrigated Cropland, Middle Rio Grande Basin, New Mexico," *New Mexico Agriculture--1970*, Agricultural Experiment Station, New Mexico State University, Research Report 195.



- \*Liesner, Dan R., *Phytophagous Insects of Tamarix spp. in New Mexico*, Unpublished Master's Thesis, Biology Department, 73 pp.
- Maker, H. J., and J. U. Anderson, *Land Classification for Irrigation, Torrance County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 187, 15 pp.
- \_\_\_\_\_, \_\_\_\_\_, and R. E. Neher, *Soil Associations and Land Classification for Irrigation, Grant County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 200, 43 pp.
- \_\_\_\_\_, \_\_\_\_\_, J. J. Folks, and W. B. Gallman, *Soil Associations and Land Classification for Irrigation, Sandoval and Los Alamos Counties*, Agricultural Experiment Station, New Mexico State University, Research Report No. 188, 45 pp.
- V. G. Link, and M. V. Hodson, *Soil Associations and Land Classification for Irrigation, Chaves County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 192, 48 pp.
- \_\_\_\_\_, G. W. Anderson, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Mora County*, Agricultural Experiment Station, New Mexico State University, Research Report 205.
- \_\_\_\_\_, R. E. Neher, P. H. Derr, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Dona Ana County*, Agricultural Experiment Station, New Mexico State University, Research Report No. 183, 41 pp.
- \_\_\_\_\_, J. J. Folks, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Santa Fe County*, Agricultural Experiment Station, New Mexico State University, Research Report 185.
- \_\_\_\_\_, V. G. Link, J. U. Anderson, and W. B. Gallman, *Soil Associations and Land Classification for Irrigation, Quay County*, Agricultural Experiment Station, New Mexico State University, Research Report 202.
- \_\_\_\_\_, \_\_\_\_\_, W. B. Gallman, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, De Baca County*, Agricultural Experiment Station, New Mexico State University, Research Report 206, 44 pp.
- \_\_\_\_\_, M. T. Turner, W. B. Gallman, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Lincoln County*, Agricultural Experiment Station, New Mexico State University, Research Report 212.
- \*Mishaeli, David, *A Dynamic Decision Model Evaluating Alternative Policies for Long Run Water Allocation*, Unpublished Ph.D. Dissertation, Department of Economics, University of New Mexico.
- \*Richardson, Gary L., *Water Table Investigation in the Mesilla Valley*, Unpublished Master's Thesis, Civil Engineering Department, New Mexico State University.
- Saleem, Z. A., and C. E. Jacob, *Dynamic Programming Model and Quantitative Analysis, Roswell Basin, New Mexico*, New Mexico State University, WRRRI Report No. 10, 180 pp.

\*Smith, G. S., John D. Tracy, E. C. Smith, and A. L. Neumann, "Bioassays of Water Quality: Mice and Rumen Culture," *Journal of Animal Science*, Vol. 33, p. 310 (Abstract).

Stucky, H. R., R. R. Lansford, and B. J. Creel, *Citizens' Conferences on Water--1971: A Consideration of the pressing water problems of New Mexico--with citizens' recommendations*, New Mexico State University, WRRi Report No. 11, 126 pp.

\*Tracy, John D., *Mouse Growth and Reproduction in Bioassays of Water Quality from Certain Natural and Municipal Water Sources in New Mexico*, Master's Thesis, Animal Science Department, New Mexico State University.

### 1972

\*Bigbee, P. D., *Pollution Studies of the Regional Ogallala Aquifer at Portales, New Mexico*, Unpublished Master's Thesis, College of Liberal Arts and Sciences, Eastern New Mexico University, 69 pp.

\*Bigbee, P. D., and R. G. Taylor, *Pollution Studies of the Regional Ogallala Aquifer at Portales, New Mexico*, New Mexico State University, WRRi Report No. 005, 30 pp.

Brown, F. L., *The Reuse of Water in Manufacturing: An Explanatory Economic Model With Data Analysis*, New Mexico State University, WRRi Technical Completion Report B-017-NMEX and A-025-NMEX, 27 pp.

Buethel, C., and A. Fitzpatrick, *School Learning Materials on Water Problems of New Mexico and the Southwest*, New Mexico State University, WRRi Report 010, 18 pp.

\*Clark, J. W., "Salinity Problems in the Rio Grande Basin," Proceedings of National Conference on Managing Irrigated Agriculture to Improve Water Quality, pp. 55-66.

\*Dane, J. H., *Effect of Hysteresis on the Prediction of Infiltration, Redistribution, and Drainage of Water in Large Soil Columns*, Unpublished Master's Thesis, Agronomy Department, New Mexico State University, 98 pp.

\*Gisser, M., and A. Mercado, "Integration of the Agricultural Demand Function for Water and the Hydrologic Model of the Pecos Basin," New Mexico State University, WRRi Report No. 004, 33 pp.

Good, W. B., *Cloud Chamber Study of Water Evaporation*, New Mexico State University, WRRi Report No. 009, 52 pp.

\*Kidd, D. E., and G. V. Johnson, *An Investigation of Primary Productivity Using the <sup>14</sup>C Method and An Analysis of Nutrients in Elephant Butte Reservoir*. WRRi Technical Completion Report A-021-NMEX, New Mexico State University, 106 pp.

- \*Loftin, Steven E., *An Expansion Cloud Chamber Study of Water Evaporation*, Master's Thesis, Physics Department, New Mexico State University, 75 pp.
- Maker, H. J., P. S. Derr, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Otero County*, Agricultural Experiment Station, New Mexico State University, Research Report 238.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and V. G. Link, *Soil Associations and Land Classification for Irrigation, San Miguel County*, Agricultural Experiment Station, New Mexico State University, Research Report 221.
- \_\_\_\_\_, J. M. Downs, and J. U. Anderson, "Soil Associations and Land Classification for Irrigation, Sierra County," New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 233.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, "Soil Associations and Land Classification for Irrigation, Socorro County," New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 234.
- Maker, H. J., R. E. Nehr, and J. U. Anderson, "Soil Associations and Land Classification for Irrigation, Catron County," New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 229.
- Maker, H. J., G. W. Anderson, and J. U. Anderson, "Soil Associations and Land Classification for Irrigation, Colfax County," New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 239.
- \*Mercado, A., "The Kinetics of Mineral Dissolution in Aquifers and Their Use for Hydrologic Investigations," Ph.D. Dissertation, Geosciences Department, New Mexico Institute of Mining and Technology.
- Midkiff, W. S., "A Method of Demineralization Using Strongly Basic Ion Exchange Resins," Engineering Experiment Station, New Mexico State University, WRRRI Technical Completion Report, 55 pp.
- Rabinowitz, D. D., and Gerardo Wolfgang Gross, *Environmental Tritium as a Hydrometeorologic Tool in the Roswell Basin, New Mexico*, New Mexico State University, WRRRI Report No. 016, 268 pp.
- Randall, A., and J. Dewbre, "Inventory of Water Diversions and Rate Structures for Cities, Towns, and Villages in New Mexico," Agricultural Experiment Station, New Mexico State University, Research Report No. 241, 50 pp.
- Richardson, G. L., and T. G. Gebhard, Jr., "Preliminary Ground Water Model of the Mesilla Valley," *Proceedings of the Seventeenth Annual New Mexico Water Conference*, New Mexico State University, WRRRI Report No. 007, pp. 44-65.
- Roach, F., and Shaul Ben-David, "An Interpretation of Water Use Data for the Rio Grande in New Mexico," *Proceedings of the Seventeenth Annual New Mexico Water Conference*, New Mexico State University, WRRRI Report No. 007, pp. 66-95.

- Smith, G. S., *Bioassays of Quality in Water Resources of Major Importance to New Mexico*, New Mexico State University, WRRRI Report No. 015, 82 pp.
- \* Taylor, R. G., "Pollution Studies of the Regional Ogallala Aquifer at Portales, New Mexico," New Mexico State University, WRRRI Report No. 008, 21 pp.
- \* Taylor, R. G., and P. D. Bigbee, "Fluctuations in Nitrate Concentrations Utilized as an Assessment of Agricultural Contamination to an Aquifer of a Semiarid Climatic Region," New Mexico State University, WRRRI Report No. 006, 12 pp.
- \* Vanderborgh, N. E., and A. G. Buyers, "A Study of Phosphate Induced Algal Growth in Order to Suppress or Eliminate This Phenomenon," New Mexico State University, WRRRI Report No. 003, 35 pp.
- \* Westcot, D. E., "Simultaneous Transfer of Heat and Water Vapor in a Closed Soil System," Unpublished Master's Thesis, Department of Agronomy, New Mexico State University, 96 pp.
- \* Wierenga, P. J., and T. C. Patterson, "Irrigation Return Flow Studies in the Mesilla Valley," *Managing Irrigated Agriculture to Improve Water Quality*, Proceedings of National Conference on Managing Irrigated Agriculture to Improve Water Quality, pp. 173-180.
- \* Wierenga, P. J., and T. C. Patterson, Project 13030 GLM, *Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation*, Annual Report, New Mexico State University, WRRRI Report No. 002, 23 pp.
- \* \_\_\_\_\_, and \_\_\_\_\_, Project 13030 GLM, *Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation - July, August and September - 1972*, Quarterly Progress Report, New Mexico State University, WRRRI Report No. 011, 12 pp.
- G. A. O'Connor, and H. E. Dregne, *Soil and Water Management for Salinity Control*, New Mexico State University, WRRRI Report No. 018, 57 pp.

### 1973

- Baker, Don H., III, Carl J. Popp, and Donald K. Brandvold, "Mercury Uptake by Fish in Natural and Artificial Systems," *Proceedings of the Eighteenth Annual New Mexico Water Conference*, New Mexico State University, WRRRI Report No. 026, pp. 40-49.
- \* Baker, Don H., III, "Mercury: Uptake by the Goldfish, *Carassius auratus*, from Low Concentrations in Water and its Tissue Distribution," Master's Thesis, Department of Chemistry, New Mexico Institute of Mining and Technology, 37 pp.

- Brandvold, D. K., "Chemical and Biological Character of Rio Grande Water in the Bosque del Apache Wildlife Refuge," New Mexico State University, WRRRI Report No. 030, 50 pp.
- Brutsaert, W., and C. Way, *A Conjunctive Use Surface Water - Ground Water Simulator*, New Mexico State University, WRRRI Report No. 033, 62 pp.
- Chavez, Fabian, III, and D. J. Cotter, "A Study of Water Used on Urban Landscapes," *Proceedings of the Eighteenth Annual New Mexico Water Conference*, New Mexico State University, WRRRI Report No. 026, pp. 30-39.
- Christiansen, P. W., "The Quest for Water in New Mexico," New Mexico Institute of Mining and Technology, WRRRI Report No. 029, 65 pp.
- \*Covington, W. W., "Altitudinal Variation of Chlorophyll Concentration and Reflectance of the Bark of *Populus Tremuloides*," Unpublished Master's Thesis, Biology Department, University of New Mexico 32 pp.
- \*Cunningham, G. L., J. G. Fraser, and R. E. Grieve, and Wolfe H. G., "A Comparison of Rates of Water Loss Through Transpiration of Several Southern New Mexico Pinnateophyte Species," New Mexico State University, WRRRI Report No. 025, 32 pp.
- \*Garcia, John D., "A Study of Mercurials in the Elephant Butte Reservoir Ecosystem," Ph.D. Dissertation, Biology Department, University of New Mexico, 128 pp.
- Gosz, J. R., "Hydrologic Nutrient Cycle Interactions in Undisturbed and Manipulated Ecosystems (Watersheds)," New Mexico State University, WRRRI Report No. 031, 29 pp.
- Lansford, R. R., and Roger D. Latham, "Planted Cropland Acreage in New Mexico in 1971 and 1972," *New Mexico Agriculture--1972*, New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 260.
- \_\_\_\_\_, \_\_\_\_\_, and Bobby J. Creel, "Irrigation Water Diversions and Depletions," *New Mexico Agriculture--1972*, Agricultural Experiment Station, New Mexico State University, Research Report 260.
- Lansford, R. R., Shaul Ben-David, Thomas G. Gebhard, Jr., Willem Brutsaert, and Bobby J. Creel, *An Analytical Interdisciplinary Evaluation of the Utilization of the Water Resources of the Rio Grande in New Mexico*, New Mexico State University, WRRRI Technical Completion Report No. 020, 152 pp.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *An Analytical Interdisciplinary Evaluation of the Utilization of Water Resources of the Rio Grande in New Mexico: Upper Rio Grande Region*, New Mexico State University, WRRRI Report No. 21, 82 pp.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, *An Analytical Interdisciplinary Evaluation of the Utilization of Water Resources of the Rio Grande in New Mexico: Middle Rio Grande Region*, New Mexico State University, WRRRI Report No. 22, 99 pp.

- Maker, H. J., W. B. Gallman, V. G. Link, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Guadalupe County, New Mexico* Agricultural Experiment Station, New Mexico State University, Research Report 246.
- \_\_\_\_\_, H. B. Maxwell, and J. U. Anderson, *Soil Associations and Land Classification for Irrigation, Union County,*" New Mexico Agricultural Experiment Station, New Mexico State University, Research Report 250.
- \*Popp, Carl J., Rollie Schafer, Don Baker, III, and Donald K. Brandvold, "Mercury Uptake by Fish from Low Concentrations in Natural Water," Submitted to *Science*,
- Reiter, Marshall, and Allan R. Sanford, "Measurement of Groundwater Flow Using an In-Situ Thermal Probe," New Mexico State University, WRRRI Report No. 027, 31 pp.
- \*Rogers, J. C., *Some Aspects of the Role of Usnic Acid in Forest Ecology*, Unpublished Master's Thesis, Biology Department, University of New Mexico, 59 pp.
- \*Saleem, Z. A., *Simulation of Coupled Leaky Aquifers and Surface-Water System*, New Mexico State University, WRRRI Report No. 017, 70 pp.
- Wierenga, P. J., *Irrigation Management and its Effect on the Quality of Drainage Return Flow*, Abstract in *Science and Man in the Americas*, Desert and Arid Lands Central Theme, AAAS, Mexico City.
- \*Wierenga, P. J., and Ted C. Patterson, *Project 13030 GLM, Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation - October, November, and December - 1972, Quarterly Progress Report*, New Mexico State University, WRRRI Report No. 012, 19 pp.
- \*\_\_\_\_\_, and \_\_\_\_\_, *Project 13030 GLM, Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation - January, February, and March - 1973, Quarterly Progress Report*, New Mexico State University, WRRRI Report No. 013, 12 pp.
- \*\_\_\_\_\_, and \_\_\_\_\_, *Project 13030 GLM, Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation, Annual Report, July 1, 1972 - June 30, 1973*, New Mexico State University, WRRRI Report No. 14, 40 pp.
- \*\_\_\_\_\_, and \_\_\_\_\_, *Project 13030 Gln, Quality and Quantity of Return Flow as Influenced by Trickle and Surface Irrigation - July, August, and September - 1973, Quarterly Progress Report*, New Mexico State University, WRRRI Report No. 32, 7 pp.
- \*Williams, K. R., *The Relationship of Soil Temperature and Cytokinin Production in Aspen Invasion*, Unpublished Master's Thesis, Biology Department, University of New Mexico.
- Wilson, Donald B., *Thermal Pollution Reduction by Adiabatic Degassing*, New Mexico State University, WRRRI Report No. 019, 76 pp.

PAPERS IN NEW MEXICO WATER CONFERENCE PROCEEDINGS

Special Report No. 1: "WATER RESOURCES AND THEIR ECONOMIC IMPORTANCE IN NEW MEXICO," (A set of papers presented at a staff and Graduate Seminar conducted by the Agricultural Economics Department, New Mexico College of Agriculture and Mechanic Arts, September, 1956).

- Stucky, H. R., "Source and Disappearance of the Total Water Supply in New Mexico," pp. 1-7.
- Evans, Morris, "A Brief Review of Surface Water Studies in New Mexico," pp. 8-12.
- Stephens, W. P., "General Observations on Underground Water in New Mexico," pp. 13-20.
- Harris, C. D., "Legal Status of Water in New Mexico," pp. 21-32.
- Elmendorf, H. B., "The Watershed Protection Program -- Public Law 566," pp. 33-40.
- Young, Robert, "The Soil and Water Conservation Program in New Mexico," pp. 41-46.
- Hardaway, George, "Water Production from Forest Lands of New Mexico," pp. 47-51.
- Fletcher, Joel E., "Southwest Watershed Studies of Agricultural Research Service," pp. 52-54.
- Reynolds, S. E., "The Effects of Interstate Compacts on New Mexico Water Supply," pp. 55-71.
- Hill, Leon, "Irrigation Developments by the Bureau of Reclamation in New Mexico," pp. 72-76.
- Moser, T. H., "Water Supply and Cost of Operation of Rio Grande Project," pp. 77-85.
- Charles, Ralph, "The Colorado River Storage Project and Participating Projects," pp. 86-95.
- Conover, C. S., "Ground Water: Its Importance to the Economy of New Mexico," pp. 96-106.
- Miller, W. T., "Streamflow Investigations of the U.S. Geological Survey in New Mexico," pp. 107-111.

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Martin, J. T., "Hydrologic Aspects of Planning Flood Control Works in New Mexico," pp. 134-136.

Gregg, J. L., "Problems of the Elephant Butte Irrigation District," pp. 137-140.

Bromilow, Frank, "Stream Flow Studies in the Mesilla Valley," pp. 141-145.

FIRST ANNUAL WATER CONFERENCE - October 31 and November 1-2, 1956.

Reynolds, S. E., "Water Resources of New Mexico," pp. 6-17.

Stephens, W. P., "Economics of the Use of Underground Water," pp. 18-26.

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Phinizy, J. A., "Underground Water Problems in the Pecos Valley," pp. 34-36.

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Dortignac, E. J., "Water Yields Through Watershed Management in New Mexico," pp. 69-97.

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Martinez, Ernest, "The Water Supply of the Upper Rio Grande River," pp. 109-110.

Meriwether, Carl, "Rio Grande Water for Industrial and Municipal Use," pp. 111-112.

SECOND ANNUAL WATER CONFERENCE - November 7-8, 1957

Black, R. H., "New Mexico A&M's Interest in the State Water Problems," pp. 5-6.

Butler, C. C., "Public Recognition of the Nation's Water Problems," pp. 7-17.

Inmon, Thelma, "Women's Viewpoint on Our State Water Problems," pp. 19-20.

Minton, E. G. Jr., "Public Recognition of New Mexico's Water Problems - The County Government's Point of View," pp. 21-23.

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Harris, C. D., "Beneficial Use, Preferential Rights, Problems in Transfer of Water Rights, and Other Problems Under New Mexico Statutes," pp. 65-71.

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Bromilow, Frank, "Income Producing Value of Water When Used by Different Industries Including Agriculture and in the Various Areas of New Mexico," pp. 105-106c.

Stucky, H. R., "Economic Evaluation of Water for New Irrigation," pp. 107-109.

THIRD ANNUAL WATER CONFERENCE - November 6-7, 1958 - "NEW MEXICO WATER - PRESENT USE AND NEW SOURCES"

Black, R. H., "Orientation of Water Resources Research and Welcome Address," pp. 6-10.

Anderson, C. P., "Congressional Interest in Water Resources," pp. 11-27.

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- Hale, W. E., "Comments on Development of Ground Water Resources Current Investigations, and Plans for Future Studies in New Mexico," pp. 137-139.
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FOURTH ANNUAL NEW MEXICO WATER CONFERENCE - November 5-6, 1959 - "WATER AND WATER LAW"

- Hutchins, W. A., "Pueblo Rights in the West," pp. 1-20.
- Sanders, T. T., "Problems of the Interstate Stream Commission," pp. 21-28.
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- Curry, A. S., "Water Research Needs for New Mexico," pp. 82-87.
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FIFTH ANNUAL NEW MEXICO WATER CONFERENCE - November 1-2, 1960 - "WATERSHED MANAGEMENT"

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- Reynolds, S. E., "An Outline of the Statutes Governing the Appropriation and Use of Ground Water in New Mexico," pp. 79-82.
- Cuykendall, John W., "Administration of Colorado Ground Water Law," pp. 83-86.

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ELEVENTH ANNUAL NEW MEXICO WATER CONFERENCE - March 31 and April 1, 1966 -  
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- Williams, B. C., "Soil Type and Soil Condition Effects Upon Value of Water Applied for Crop Production," pp. 136-144.
- Baltensperger, Arden A., "Crop Plants - Water Use and Salt Tolerance," p. 145.
- Dregne, H. E., "Water Qualities and Needs in Relation to Crop Yields," pp. 154-157.

TWELFTH ANNUAL NEW MEXICO WATER CONFERENCE - March 30-31, 1967 - "WATER QUALITY - HOW DOES IT AFFECT YOU?"

- Agee, James L., "The Development of Water Quality Standards," pp. 9-12.
- Hernandez, John W., "Consequences, to New Mexico of Water Quality Standards on Interstate Streams," pp. 13-17.

- Cargo, Governor David F., "New Mexico's Interest in Water," pp. 18-22.
- Clark, John W., "Stream Pollution and Measurement," pp. 23-31.
- Longenecker, D. E., "Water Requirements for Crop Production with Saline Waters and Saline Soils," pp. 32-38.
- Lazrus, A. L., "A Comparison of Minor Trace Contaminants in Atmospheric Precipitation and in Water Supplies," pp. 39-43.
- Calhoun, Lloyd A., "Career Opportunities in the Water Resources Area (With Emphasis on the Area of Petroleum)," pp. 44-47.
- Elliott, Frank O., "Career Opportunities in the Water Resources Area As Related to the Oil Industry," pp. 48-49.
- Koopman, F. C., "Government Career Opportunities in Water Resources," pp. 49-51.
- Keyes, Conrad G. Jr., "Career Opportunities in the Water Resources Field As They Appear to Students and Specifically in the Educational Field," pp. 51-52.
- Eaton, E. D., "Career Opportunities in Water Resources Research," pp. 53-55.
- Leyendecker, Philip J., "Agricultural Career Opportunities in the Water Resources Area," pp. 56-58.
- Jacob, C. E., "Geologic and Hydrologic Research Relating to Water Resource Research in New Mexico," p. 59.
- Titus, Frank B., "Education and Research Needs in Hydrology," pp. 60-61.
- McDonald, Harris, "Water Quality Relationships in Irrigation Development," pp. 62-74.
- Flaxman, Elliott M., "Sediment and Its Effect on Water Quality," pp. 75-82.
- Street, Haskell R., "Water Quality Relationships for Urban and Industrial Uses," pp. 83-94.
- Arnold, Maurice D., "Water Quality Requirements and Relationships for Recreational Use," pp. 95-103.
- Flint, F. Harlan, "1967 Water Legislation," pp. 104-112.
- Pattison, Hoyt, "Water Legislation - 1967," pp. 113-116.

THIRTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - March 28-29, 1968 - "WATER FOR NEW MEXICO TO THE YEAR 2000 AND 2060"

- Cargo, Governor David F., "Water for New Mexico to the Year 2000 and 2060," pp. 9-10.
- Calhoun, Lloyd A., "Water in New Mexico's Future," pp. 11-17.
- Kendrick, John J., "Water Importation to West Texas and New Mexico," pp. 18-24.
- Beaty, Orren Jr., "Four Corners Economic Development, Water and People," pp. 25-30.
- Dominy, Floyd E., "Water Supplies for the Southwest - What of the Future," pp. 31-37.
- Edgel, Ralph, "Projections of the Population of New Mexico to the Year 2070," pp. 39-47.
- Ortiz, Arthur, "Comprehensive State Planning As A Framework for Water Resource Development," pp. 48-58.
- Hill, Leon W., "Reclamation Activities in New Mexico," pp. 59-66.
- Reynolds, S. E., "Water Development and Planning for New Mexico," pp. 67-81.
- Lyon, Fern, "Women's Interest in Water Problems," pp. 82-89.
- Zarazua, Ing. Carlos Carvajal, "Water Resources Planning in the State of Chihuahua," pp. 90-94.
- Shoemaker, Dennis E., "Overpopulation and You," pp. 95-107.
- Dawson, George R., "Water Uses for the Next Hundred Years," pp. 109-111.
- Hernandez, John W., "New Mexico Municipal, Domestic and Industrial Water Supply Demands, 1962-2068," pp. 112-122.
- Gray, James R., "Recreational Water Needs in New Mexico for the Next Hundred Years," pp. 123-136.
- Hanson, Marlin L., "Irrigation Water Needs in New Mexico for the Next Hundred Years," pp. 137-153.
- Dawson, George R., "Water Uses for the Next Hundred Years - A Summary Statement," pp. 154-159.
- Renne, Roland R., "Meeting Future Water Needs," pp. 160-167.

FOURTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - March 27-28, 1969 - "WATER RESEARCH AND DEVELOPMENT"

- Corbett, Dr. R. B., "Water Research and Development in New Mexico," pp. 12-14.

- Bingham, Jay R., "The Western States Water Council," pp. 15-20.
- Seward, Lewis B., "The Texas Water Plan - Imports to Texas and New Mexico," pp. 21-25.
- Montoya, Joseph M., "New Mexico and Southwest Water," pp. 26-28.
- Hennighausen, Fred H., "Meters and Their Effects in the Roswell Artesia Basin in Chaves and Eddy Counties, New Mexico," pp. 29-33.
- Reynolds, S. E., "Colorado River Basin Project Act As It Affects New Mexico," pp. 34-43.
- Bolack, Governor Tom, "Water Conservation and Development in the Farmington Area and in the State," pp. 44-48.
- Levine, Bert, "Navajo Indian Irrigation Project," pp. 49-54.
- Cannon, D.E., "San Juan-Chama Project," pp. 55-59.
- Reinig, L. P., "Potentials for Water Development With Atomic Power," pp. 63-75.
- Lunsford, Jesse V., "Water Potentials of Weather Modification," pp. 76-85.
- Hanson, Eldon G., "The Future of Subsurface Irrigation: A Method of Saving Water," pp. 86-99.
- Williams, B. C., "Future of Subsurface Irrigation: Influence on Cotton Yields and Quality," pp. 100-111.

FIFTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - March 12-13, 1970 - "WATER - THERE IS NO SUBSTITUTE"

- O'Meara, J. W. "Pat", "Future Water Supplies Through Desalting," pp. 15-19.
- Hershey, H. Garland, "Value of Water Research to State and Nation," pp. 20-26.
- Whitsett, Colonel Menon W., "Water Resources Development by Corps of Engineers," pp. 27-31.
- Jones, Ancil A., "Water Pollution Control Program in the Southwest," pp. 32-40.
- Wright, John R., "Need for Effluent Standards," pp. 41-44.
- Bronn, Carl, "The Social Benefits of Natural Resources Development," pp. 45-52.
- Stevens, Thompson & Runyan, Inc., "Quality vs. Quantity Relationships from TUALATIN BASIN WATER AND SEWERAGE MASTER PLAN," p. 53.
- Little, J. Warner, "Albuquerque's Planning for the Use of San Juan Water," pp. 54-47.

- Flint, F. Harlan, "The San Juan-Chama Project: Foundation for Administration," pp. 58-63.
- Dick-Peddie, William A., "Effects of Water Management on the Ecology of the Area," pp. 64-67.
- Linn, Max, "Water Planning for Equilibrium," pp. 68-78.
- Lansford, Robert R., "Irrigation Water Requirements for Crop Production in the Roswell Artesian Basin," pp. 79-91.
- Ott, Gene O., "Adjustments in Cropping Patterns As A Means of Saving Water," pp. 92-94.
- McLean, J. S., "Objectives of A Current Study of Saline Ground Water in the Tularosa Basin, New Mexico," pp. 95-100.
- Slingerland, Carl, "New Mexico State Water Plan," pp. 101-103.
- Anderson, J. U., "Irrigability Classification of New Mexico Lands," pp. 104-110.
- Foreman, Ed, "Preserving New Mexico's Water Resources," pp. 111-113.

SIXTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - March 25-26, 1971 - "WATER - A KEY TO A QUALITY ENVIRONMENT"

- Thomas, Gerald W., "Water - A Key to A Quality Environment - New Mexico and The Southwest," pp. 16-20.
- Gilmer, Jesse, "Comprehensive Study on the Rio Grande - San Marcial, New Mexico to Fort Quitman, Texas," pp. 21-25.
- Cunningham, Wayne, "Problems and Projects of the Elephant Butte Irrigation District," pp. 26-31.
- Bouwer, Herman C., "Renovating Sewage Effluent by Groundwater Recharge," pp. 32-46.
- King, Bruce, "Water and New Mexico's Welfare," pp. 47-51.
- Agnew, Allen, "Solutions to Water Problems - The Time Is Now," pp. 52-63.
- Bartlett, E. T., "Systems Analysis In Natural Resources Management," pp. 66-71.
- Peterson, Dean Eldon, and Deason, Larry L., "Arizona's Groundwater Problem and Proposed Legislation," pp. 72-89.
- Quintana, Jose Macias and Diaz, Jaime Leal, "Importance of the Irrigation of Corn (*Zea mays*, L.) During Its Maximum Rate of Transpiration Period," pp. 90-100.

Cunningham, Robert S., "Antitranspirants: A Possible Alternative to the Eradication of Saltcedar Thickets," pp. 101-109.

Mann, David, "Sediment: The Critical Aspect of Future Water Quality in the Aspen, Colorado Region," pp. 110-121.

Wocknitz, Robert W., "The Potential Contamination of Surface Waters by Herbicides," pp. 122-129.

Creel, Bobby J., "Monthly Consumptive Irrigation Requirements As A Guide to Efficient Management," pp. 130-138.

Gorman, W. D., "Impact of Water Development for the Navajos," pp. 141-149.

Bell, Ralph M., "Land and Water Problem Solving On the Upper Rio Grande," pp. 150-166.

Clayton, Bill, "Water Import to West Texas and New Mexico," pp. 167-172.

Clark, Ira, G., "The Historical Approach to Water Law - Its Value and Its Problems," pp. 173-178.

West, Colonel R. L., "Cochiti - A Key Water Resource Development for New Mexico," pp. 179-197.

SEVENTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - April 6-7, 1972 - "WATER IN LAND USE PLANNING"

Evans, Norman A., "Water in Land Use Planning," pp. 1-7.

Kahan, Archie M., "Project Skywater - A Progress Report," pp. 8-14.

Eichelmann, John Jr., "A New Technology for Pollution Abatement," pp. 15-20.

Clusen, Mrs. Donald E., "The Citizen in Water and Land Use Planning," pp. 21-27.

PANEL - Water In Land Development

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John Wright pp. 32-35

Harvey Mudd pp. 36-40

Carter Kirk pp. 41-43

Richardson, Gary L. and Gebhard, Thomas, G. Jr., "Preliminary Ground-Water Model of the Mesilla Valley," pp. 44-65.

Roach, Fred and Ben-David, S., "An Interpretation of Water Use Data for the Rio Grande in New Mexico," pp. 66-94.

Rabinowitz, D. Dan and Gross, G. W., "Environmental Tritium As Hydrologic Tool - Roswell Artesian Basin," pp. 96-106.

Erb, R. Bryan, "A 'Big Picture' for Resource Management A View of Earth from Space," pp. 107-109.

Munson, R. B., "Potential Applications of Aerospace Earth Observations Technology to the Problems of the Rio Grande," pp. 110-123.

PANEL - Citizens' Water Conferences

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EIGHTEENTH ANNUAL NEW MEXICO WATER CONFERENCE - April 5-6, 1973 - "STATE WATER PLAN"

Fairchild, Warren D. (Presented by Daniel V. McCarthy), "A Look Into The Future," pp. 2-9.

Reynolds, S. E., "State Water Plan," pp. 10-18.

Zink, Lee B., "Population Projections for the New Mexico State Water Plan," pp. 19-29.

Chavez, Fabian, III, and Cotter, Donald J., "A Study of Water Used on Urban Landscapes," pp. 30-39.

Baker, Don H., III, Popp, Carl J., and Brandvold, Donald K., "Uptake of Mercury by Fish in Natural and Artificial Systems" pp. 40-49.

Reinig, L. P., Brasier, R. I., Donham, B. J., and Gregory, W. S., "Another Rio Grande for New Mexico?" pp. 50-61.

Paquette, A. J., and Beychock, M. R., "Clean Energy Via Coal Gasification," pp. 62-77.

Burleigh, Harry P. (Presented by Lewis B. Seward), "Report by the National Water Commission - A Review," pp. 78-83.

APPENDIX--C

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