Water Resources Research Institute
Annual Technical Report
FY 2003

Introduction

This program report provides the required information for projects funded with the 2003 base grant and mandatory non-federal matching funds. Please note that there may be some overlap in information with our 2002 report because data collection is based on a July-June fiscal year rather than the March-February USGS Grant Award period.

The New Mexico Water Resources Research Institute (NMWRRI) was established in 1963 by the New Mexico State University Board of Regents, becoming one of the first of the 54 state institutes approved nationwide under the authorization of the 1964 Water Resources Research Act. It is considered to be the statewide nucleus for coordinating water resources research. Using the expertise of researchers in a variety of disciplines at state-supported universities, the institute is able to respond to the critical water needs of New Mexico and the region. It operates under the general advice of a Program Development and Review Board, whose membership includes faculty representatives as well as state and federal agency personnel.

The mission of the NMWRRI is to develop and disseminate knowledge that will assist the state, region, and nation in solving water resources problems. Specifically, the institute encourages university faculty statewide to pursue critical areas of water resources research while providing training opportunities for students who will become our future water resources scientists, technicians, and managers. It provides an outlet for transferring research findings and other related information to keep water managers and the general public informed about new technology and research advances. In addition, the institute maintains a unique infrastructure that links it with many federal, state, regional, and local entities to provide expertise and specialized assistance.

The institute maintains a vigorous program to transfer technical information from the producer to the user and the public. Technical publications, newsletters, conferences, press announcements, and presentations keep practitioners aware of new technology and research advances. NMWRRI homepage (http://wrri.nmsu.edu) provides on-line information about the institute, newsletters, technical report series, requests for proposals, upcoming conferences, links to related entities, and the research reference library.

One of the driest states in the nation, New Mexico's average annual precipitation is no more than 20 inches, varying from about 8 inches in the desert valleys to more than 30 inches in the high mountains. The relative humidity is low, resulting in a high rate of evaporation. Summer rain accounts for almost half the annual precipitation other than in the high mountains. Such widely varied precipitation is as much a water allocation problem as water scarcity itself. New Mexico, like much of the West, has suffered drought conditions throughout the latter half of the 1990s as well as the past four years. Speculation is that the region might be headed into a long-term dry spell that could last decades. Snowpack, critical to the water supply, has been well below normal throughout the state. Reservoirs have reached record low storage levels. Water conservation measures have been expanded in municipalities throughout New Mexico to help ensure adequate public water supplies for residential and industrial use. Drought ordinances are in place in cities across the state, and county and municipal governments are working

together to limit water use and reduce demand. In April 2002, New Mexico's governor declared a state of emergency because of the drought. Officials say this is the most significant drought since the mid-1950s.

Like other western states, New Mexico's water problems continue to revolve around three key issues: quality, quantity, and management. Because water resources are so limited, water quality and water resources management have taken on increasing importance. These concerns are interrelated and sufficiently complex so that the highest quality research is essential to solving them.

Research Program

The primary objective of the New Mexico Water Resources Research Institute is to maintain a balanced program of research that addresses water issues and problems critical to New Mexico, the region, and the nation. In administering this program, the institute relies on financial support from state appropriations as well as federal and state agencies, and the USGS Water Resources Research Institute Annual Base Program. A project funded in the 2003 Annual Base Program is entitled Information Management Program and Geographic Information Systems for Water Resources Research Planning, which focused on conservation, management, and planning.

During the reporting period, the NMWRRI administered a total of 24 projects dealing primarily with water quality and conservation issues. The total value of these projects was nearly $2.2 million, including required cost sharing. Awards were made by various federal and state agencies, a private foundation, and from the institutes annual state appropriations. Dollar amounts per project award ranged from under $2,370 to nearly $940,000. Although research projects are typically conducted at the three major universities in New Mexico (University of New Mexico, New Mexico Tech, and New Mexico State University), during the reporting period all projects were conducted at NMSU. Faculty members were principal investigators on 13 projects and NMWRRI staff managed 16 projects. The institute maintained frequent contact with its researchers through periodic progress updates, site visits, and expenditure tracking.

Research projects administered by the NMWRRI utilized at least 37 students during the year including undergraduates, masters, and Ph.D. candidates. A water resources summer training program provided a broad understanding of water resources to approximately 30 Native American high school students from across the nation.

Projects administered by the NM Water Resources Research Institute during the reporting period that were funded from sources other than the 2003 USGS Annual Base Program are listed below. Note that total award value is shown and includes both agency and cost sharing when appropriate.

Mapping Services - Regional Water Plan Task Orders. Professional Services Agreement with the NM Interstate Stream Commission (three projects) $8,130

Preparation of a Strategic Plan and Bylaws for the Paso del Norte Water Task Force. The William and Flora Hewlett Foundation $100,000

Salinity Sources of the Hueco Bolson. Subcontract with California State University - Los Angeles $36,002

Riparian Evapotranspiration Study of the Middle Rio Grande. US Bureau of Reclamation, NMWRRI and New Mexico State University $939,096

Water Resources Training Program for Native American Students. US Bureau of Indian Affairs $94,244

Technical Information Coordination for the Tularosa Basin National Desalination Research Center. Sandia National Laboratories $50,000

Surface Enhanced Raman Spectroscopic Detection of Water-Borne Pathogens. New Mexico Water Resources Research Institute state appropriations $7,500

Development of a Prototype Coordinated Database Project for the Paso del Norte Watershed Council. Texas A&M University, Agricultural Research and Experiment Center at El Paso $28,350

Digital Hydrologic Framework. Lower Rio Grande Water Users Organization $83,924

Measuring Evapotranspiration Depletion in the Middle Rio Grande Bosque. New Mexico Interstate Stream Commission $304,436

Early Life History Studies of Rio Grande Silvery Minnow (Hybognathus amarus) Related to Downstream Fish Passage. U.S. Bureau of Reclamation $70,442

Water Conveyance Habitat Assessment for the Middle Rio Grande Conservancy District. Bureau of Reclamation $35,591

Analysis of Raw and Treated Sewage to Determine the Effectiveness of Sewage Treatment and Levels of Enteric Disease Along the Paso del Norte Region. SCERP and Water Resources Research Institute state appropriations $46,951

New Mexico Environment Departments U.S.-Mexico Border GIS Project. New Mexico Environment Department and NMSU College of Business $4,850

On-Farm Efficiency Investigations in the Middle Rio Grande. URS Group, Inc. from Bureau of Reclamation $87,838

Digital Conversion of Maps of the Robledo Mountains. New Mexico Bureau of Geology and Mineral Resources $4,000

New Mexico Brackish Water Assessment Workshop. Bureau of Reclamation $9,700

An Inventory of Water Conservation Hydrology, Culture and Institutions in New Mexico. Bureau of Reclamation $9,700

Well Metering Inventory and Evaluation for Elephant Butte Irrigation District. Elephant Butte Irrigation District $4,000

Irrigation and Brackish Water Utilization Research. Sandia National Laboratories $15,000

Evapotranspiration Study of Doña Ana County. Lower Rio Grande Water Users Organization and New Mexico Water Resources Research Institute $59,543

Continuing Development of a Coordinated Water Resources Database for the Paso del Norte Watershed Council. Texas A&M University, Agricultural Research and Experiment Center at El Paso $48,183

Student Water Research Grants 2003-2004. New Mexico WRRI state appropriations $60,000

Geographic Information System for Water Resources Research Planning

Basic Information

Title:	Geographic Information System for Water Resources Research Planning
Project Number:	2002NM1B
Start Date:	3/1/2000
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	Second
Research Category:	Not Applicable
Focus Category:	Management and Planning, Conservation, Water Quality
Descriptors:	
Principal Investigators:	Bobby J. Creel, John F. Kennedy

Publication

1. Witcher, J.C., J.P. King, J.W. Hawley, J.F. Kennedy, J. Williams, M. Cleary, and L.R. Bothern, 2004, Sources of Salinity in the Rio Grande and Mesilla Basin Groundwater, New Mexico Water Resources Research Institute, Technical Completion Report No. 330, New Mexico State University, Las Cruces, New Mexico.
2. Brown, C., Z. Sheng, and M. Rich, 2004, Paso Del Norte Watershed Council Coordinated Water Resources Database Project, New Mexico Water Resources Research Institute, Technical Completion Report No. 327, New Mexico State University, Las Cruces, New Mexico.
3. Schulze-Makuch, D., P. Goodell, T.G. Kretzschmar, and J.F. Kennedy, 2003, Microbial and chemical characterization of a ground-water flow system in an intermontane basin of southern New Mexico: Hydrogeology Journal, 11:401-412.
4. Hibbs, B., F. Phillips, H. Hogan, C. Eastoe, J.W. Hawley, J.F. Kennedy, F. Nuñez, A. Granados, and T. Kretzschmar, 2003, Binational Study of the Surface and Ground Water Resources of the El Paso/Juárez International Corridor, in Rubin K. (ed.), Trans-Boundary Water Issues: The Universities Council on Water Resources, Water Resources Update, Issue No. 125, p. 25-30.

Problem and Research Objectives
The New Mexico Water Resources Research Institute has become the focal point for geographic information system (GIS) data and information concerning water resources in New Mexico. It combines database management with digital mapping into spatial-tabular data models. These models are powerful tools for representing and manipulating earth-science information.

As use of Geographic Information Systems has grown and presented new opportunities, it also has raised a number of new issues and problems. Of increasing concern is the management of a growing collection of spatial data sets and applications programs. These data sets and programs are very expensive to produce but relatively easy to share, so there is a great incentive to avoid duplicating production efforts. The trend clearly is toward managing these elements in distributed spatial libraries.

The primary objective of the project is to increase availability and accessibility of water resource information to support water resource planning and management in the state. The first task provides spatial data library accessibility**.** This task maintains arrangements and establishes those necessary to provide access to spatial data maintained by other agencies and organizations. The second task, spatial data development, evaluates needs, establishes priorities, and undertakes development of spatial data that is otherwise unavailable. These efforts will be coordinated with cooperating agencies and organizations to assure no duplication of effort and establish guidelines for coverages and priorities. The principal investigators maintain, update as necessary, and make the data available to cooperating agencies and organizations through both formal and informal arrangements to facilitate water resource planning activities.

Methodology
A number of cooperative data sharing agreements have been entered into with state, federal, and local agencies and organizations to facilitate access and to develop spatial data. Others will be pursued as necessary. Research funded by the NMWRRI in many cases results in the development of data that can be represented in a spatial form and thus can contribute to the state data pool. Projects that have such a potential are adjusted as necessary to meet this secondary purpose.

The NMWRRI maintains a GIS laboratory consisting of computer workstations, data storage devices, input/output devices (color plotter, digitizer, etc.); software for mapping and analysis (ARC/Info), database, and visualization; as well as network systems. The laboratory is connected via fiber to the New Mexico State University computer network, and thereby to the Internet. The NMWRRI also maintains an Internet web server site through which both spatial and tabular water resource data can be provided.

Principal Findings and Significance
Various research activities are supported by the system for water resources planning in the state. The New Mexico Interstate Stream Commission provides grants to regional groups to support water resources planning. NMWRRI continues to be utilized by the NM Interstate Stream Commission to provide GIS mapping products for use in their plans and in public outreach. NMWRRI has helped many regional groups with GIS mapping products for use in their plans and in public outreach efforts.

Additionally, support has been given to the New Mexico/Texas Water Commission and various public entities of southern New Mexico for their planning activities. GIS mapping support is also provided to the Lower Rio Grande Water Users Organization. Presentations utilizing the products of the database management system were given at the annual meeting of the Geological Society of America in October 2002, and at the Universities Council on Water Resources meeting in July 2002.

This sophisticated mapping and geo-spatial database management system, originally designed to support WRRI-funded research activities, is now being used for external research grants (e.g., sources of salinity in the Mesilla Valley; creation of maps for the purpose of water planning funded by the New Mexico Interstate Stream Commission; and pesticide management planning in the state funded by the New Mexico Department of Agriculture) by water resources management and planning agencies in the state. A research grant resulted in the creation of a regional geographic information system to support regional water planning in the Paso del Norte borderland area of the southwestern United States. The system also has widespread applicability for water rights administration and stream adjudications.

This is an ongoing project with new data continually being added to the database and assistance being given to produce specific GIS products upon request. Continued funding is anticipated from annual state appropriations, as well as pending agency awards.

Information Transfer Program

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Information Transfer Program

Basic Information

Title:	Information Transfer Program
Project Number:	2002NM3B
Start Date:	3/1/2000
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	Second
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	information transfer, information dissemination, education
Principal Investigators:	Bobby J. Creel, Cathy T. Ortega Klett

Publication

1. Witcher, J.C., J.P. King, J.W. Hawley, J.F. Kennedy, J. Williams, M. Cleary, and L.R. Bothern, 2004, Sources of Salinity in the Rio Grande and Mesilla Basin Groundwater. New Mexico Water Resources Research Institute, Technical Completion Report No. 330, New Mexico State University, Las Cruces, New Mexico.
2. Brown, C., Z. Sheng, and M. Rich, 2004, Paso Del Norte Watershed Council Coordinated Water Resources Database Project. New Mexico Water Resources Research Institute, Technical Completion Report No. 327, New Mexico State University, Las Cruces, New Mexico.
3. Ortega Klett, C.T., 2003, Proceedings of the 47th Annual New Mexico Water Conference, Theres No Doubt, Were in a Drought! New Mexico Water Resources Research Institute, Technical Completion Report No. 326, New Mexico State University, Las Cruces, New Mexico.
4. Moore, J.L., J.P. King. A.S. Bawazir, and T.W. Sammis, 2004, A Bibliography of Evapotranspiration with Special Emphasis on Riparian Vegetation. New Mexico Water Resources Research Institute, Miscellaneous Report No. M28, New Mexico State University, Las Cruces, New Mexico.

Statement of Critical Water Problem:
The New Mexico Water Resources Research Institute's Information Transfer Program is designed to bring the results of its research projects to the public, and to educate New Mexicans on the critical water issues of the state, region, and nation. Different sectors of the public are targeted for each of its activities.

Statement of Results and Benefits:
The program goal is to provide people with water information appropriate to their level of training and interest. Information transfer activities are funded primarily from non-federal sources. Responsibilities for different segments of the program have been assigned to various professional and support staff at the institute.

Nature, Scope and Objectives:
The primary methods for information transfer are conferences, publications, audio/visual presentations, and available information on the institute's website. For the past 48 years, the NMWRRI has sponsored the Annual New Mexico Water Conference focusing on a topic of importance to the New Mexico water community. The annual conference is held in different locations around the state, usually in the fall. Most of the conference participants are water resources practitioners working for state, federal, or local agencies, although some members of the general public and of academia also attend. Average attendance ranges between 200 and 350, depending on the location and topic of the conference.

Publications include technical completion reports resulting from NMWRRI sponsored projects, special in-house publications, and conference proceedings. The institute has published more than 360 technical and miscellaneous reports. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects. Since about 2000, technical reports are available via the NMWRRI web site in full text. Those interested in a particular report are able to print off the Internet instead of ordering a hard copy of the report.

A quarterly newsletter, *The Divining Rod,* focuses on research and current water issues. It is distributed to approximately 2,200 readers and is available on the WRRI homepage.

The institute averages about 125 requests for general information and about 20 requests for specific publications each month. A reference room, housed at the institute, contains over 10,000 documents and is used frequently by faculty, students, and others. A complete catalog of holdings can be searched through the NMWRRI home page on the Internet, along with an extensive water resources and information system database and other information about the institute. Several hundred inquires per month are recorded on the web page.

The institute director and associate director are invited frequently to speak at local, regional, and national conferences and workshops in addition to serving on a number of committees that focus on water resources. The NMWRRI staff also regularly provides expertise for solving specific problems and general concerns. They play a central role in planning for the water future of the region by cooperating with a host of water resources entities throughout the state and region.

Accomplishments:
The 48th Annual New Mexico Water Conference was held in November 2003 at the Santa Ana Pueblo, in Bernalillo, New Mexico. The conference theme, "New Mexico Water Planning 2003" drew nearly 300 participants. In late 2002, newly elected New Mexico Governor Bill Richardson called for the creation of a state water plan within a year. The NMWRRI's water conference coincided with the announcement of the final draft water plan document. The conference also included the Albert E. Utton Memorial Water Lecture given by Mexico's Ambassador Alberto Székely. The Ambassador spoke on the need for Mexico and the U.S. to cooperate on water related issues along the U.S.-Mexico border, specifically encouraging the states' governors on both sides of the border to become more active.

The NMWRRI coordinated the 2003 Water Research Symposium held on the campus of New Mexico Tech, in Socorro, New Mexico. The one-day symposium entitled "New Mexico Symposium on Hydrologic Modeling" was co-sponsored by Sandia National Laboratories, Los Alamos National Laboratory, New

Mexico's three state universities, Office of the State Engineer, New Mexico Interstate Stream Commission, and several private consulting firms. Thirty-five presentations were given and 27 posters displayed. Over 175 participants from throughout New Mexico and west Texas attended.

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The institute's publications for the period included two technical reports, one miscellaneous report, and the 47th Annual New Mexico Water Conference proceedings. NMWRRI technical completion reports are available at no charge while supplies last. A copy charge is accessed if the report is out of print or has been reprinted. Water conference proceedings and miscellaneous reports can be purchased for a small charge. All technical report abstracts can be viewed via the NMWRRI homepage and publications may be ordered at http://wrri.nmsu.edu.

The Institute's quarterly newsletter, *The Divining Rod* is an eight- to sixteen-page newsletter that focuses on research projects administered by the NMWRRI and on current water issues in New Mexico. It provides information on upcoming conferences, seminars and workshops; describes new grants and newly released publications; and provides general information on new developments in water resources research and management. Each issue is available on the NMWRRI's homepage.

The Information Transfer Program is an ongoing program with no particular timelines.

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	4	0	0	0	4
Masters	1	0	0	0	1
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	5	0	0	0	5

Notable Awards and Achievements

Project 2001 B-03 NM1421 Geographic Information System for Water Resources Planning

The New Mexico Water Resources Institute continues to be the focal point for geographic information system (GIS) data and information concerning water resources in New Mexico as well as in the El Paso/Juãrez border region. Staff gave numerous presentations including:

Kennedy, J.F. and J.W. Hawley, 2003, Late Quaternary Paleohydrology of a Linked Pluvial-Lake and Ancestral Rio Grande System, Paso Del Norte Region, Southwestern USA and Northern Mexico (abstract of poster presentation): XVI INQUA Congress, Reno Nevada, July 23-30, 2003.

Kennedy, J.F., A. Granados-Olivas, M. Herrera, E. Rascon, and J.W. Hawley, 2003, Using Mentorship and Internship Opportunities as an Effective Tool in Transboundary Aquifer Studies, Paso del Norte area, USA and Mexico (abstract of oral presentation): Geologic Society of America Meeting, Seattle, WA, 2003.

Kennedy, J.F. 2003, GIS Day 2003, Using GIS to reconstruct paleohydrography. New Mexico State University, Department of Geography in conjunction with the U.S. Forest Service. New Mexico Farm and Ranch Heritage Museum, Las Cruces, NM, 2003.

Publications from Prior Projects

1. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Articles in Refereed Scientific Journals - Li, L., T.M. Whitworth, and R. Lee, 2003, Construction of an Ultra-thin, Compacted Clay Membrane, Applied Clay Science, 24:59-68.
2. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Articles in Refereed Scientific Journals - Whitworth, T.M., U.W. Siagian, and R. Lee, 2003, Reverse Osmosis Separation of NaCl Using a Bentonite Membrane, Separation Science and Technology, 38:4009-4026.
3. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Articles in Refereed Scientific Journals - Li, L., T.M. Whitworth, and R. Lee, 2003, Separation of Inorganic Solutes from

Oil-Field Produced Water Using a Compacted Bentonite Membrane, Journal of Membrane Science, 217:215-225.

4. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Conference Proceedings - Hart, M. and T.M. Whitworth, 2002, Low-head Testing for Clay Membrane Properties, The Clay Minerals Society 29th Annual Meeting, Program and Abstracts, p. 84.
5. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Conference Proceedings - Li, L., R. Lee, and T.M. Whitworth, 2002, Solute Rejection Capabilities of Compacted Bentonite Membranes, The Clay Minersals Society 39th Annual Meeting, Program and Abstracts, p. 116.
6. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Conference Proceedings - Odour, P. and T.M. Whitworth, 2002, Transient Modeling of Hyperfiltration Effects, The Clay Minerals Society 39th Annual Meeting, Program and Abstracts, p. 139.
7. 2000NM6B ("Hyperfiltration-Induced Precipitation of Sodium Chloride") - Conference Proceedings - Ye, B. T. Fan, R. Lee, and T.M. Whitworth, 2001, Using Clays as Reverse Osmosis Membranes to Treat Produced Water, Association of Engineering Geologists Annual Meeting, Abstract, St. Louis, Missouri, 2001.
8. 2000NM3B ("Genetic Techniques for the Verification and Monitoring of Dihaloethane Biodegradation in New Mexico Aquifers") - Book Chapters - Reiss, R.A., and P. Guerra, 2003, Enzyme Assays for Estimating First-order Rate Constants of 1,2-Dichloroethane Biodegradation in Groundwater, in Water Pollution VIII: Modeling, Measuring the Prediction, Brebbia, C.A., D. Almorza, and D. Sales, (eds.), Wessex Institute of Technology Press, pp. 191-200.
9. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Conference Proceedings - Montoya, J.R., R.L. Armstrong, G.B. Smith, 2003, Surface enhanced Raman detection of Salmonella antibodies, SPIE Chemical and Biological Sensing IV, 21-25 April 21-25, 2003, Orlando, Florida.
10. 2001NM1421B ("Geographic Information System for Water Resources Research Planning") - Articles in Refereed Scientific Journals - Schulze-Makuch, D., P. Goodell, T.G. Kretzschmar, and J.F. Kennedy, 2003, Microbial and Chemical Characterization of a Ground-water Flow System in an Intermontane Basin of Southern New Mexico, Hydrogeology Journal, 11:401-412.
11. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Conference Proceedings - Smith, G.B., J.R. Montoya, C.Y. Esquivias, and R.L. Armstrong, 2004, The use of Raman spectroscopy for the detection of bacterial pathogens and their surrogates, American Society for Microbiology National Meetings, May, 2004, New Orleans, LA.
12. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Conference Proceedings - Montoya, J.R., R.L. Armstrong, G.B. Smith, 2003, Surface enhanced Raman detection of Salmonella antibodies, SPIE Chemical and Biological Sensing IV, 21-25 April21-25, 2003, Orlando, FL.