

# **Water Resources Research Institute**

## **Annual Technical Report**

### **FY 2002**

## **Introduction**

This program report provides the required information for projects funded with the 2002 base grant and mandatory non-federal matching funds. Please note that there may be some overlap in information with our 2001 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://wrii.nmsu.edu>) provides on-line information about the institute, newsletters, technical report series, requests for proposals, upcoming conferences, 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.

## 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 2002 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 21 projects dealing primarily with water quality and conservation issues. The total value of these projects was just over \$2.6 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 \$25,000 to nearly \$950,000. 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 eleven projects and NMWRRI staff managed twelve 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 50 students during the year including undergraduates, masters and Ph.D. candidates. A water resources training program provided a broad understanding of water resources to a number of 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 2002 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. \$4,920

New Mexico Pesticide Management Plan. Memorandum of Agreement with the New Mexico Department of Agriculture - US Environmental Protection Agency. \$70,000

Creating a Single Map: Combining Databases to Form a Single Regional GIS System (with University of Texas at El Paso and Universidad Autonoma de Ciudad Juarez faculty). The William and Flora Hewlett Foundation. \$75,000

Organizational Review of Transfers of Surface Water from Irrigation to Domestic Use. US Environmental Protection Agency through the Lower Rio Grande Water Users Organization. \$39,400

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, NMWRRRI and New Mexico State University. \$939,096

Evaporation Estimation at Elephant Butte Reservoir. Office of the State Engineer. \$64,010

Evapotranspiration Study of Dona Ana County. US Environmental Protection Agency through the Lower Rio Grande Water Users Organization. \$59,543

Water Resources Training Program. US Bureau of Indian Affairs. \$52,019

Sources of Salinity in Rio Grande and Mesilla Basin Aquifers. Joint Powers Agreement with the NM Interstate Stream Commission. \$150,000

Monitoring Network of the Groundwater Flow System in the Mesilla Basin. New Mexico State University. \$13,545

Potential for Water Conservation through Lining Canals in the Rio Grande. Texas A&M University, Agricultural Research and Experiment Center at El Paso. \$18,350

Technical Information Coordination for the Tularosa Basin Desalination Research Center. Sandia National Laboratories. \$24,000

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

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

# Geographic Information System for Water Resources Research Planning

## Basic Information

<b>Title:</b>	Geographic Information System for Water Resources Research Planning
<b>Project Number:</b>	2001NM1421B
<b>Start Date:</b>	3/1/2000
<b>End Date:</b>	2/28/2004
<b>Funding Source:</b>	104B
<b>Congressional District:</b>	2nd
<b>Research Category:</b>	Not Applicable
<b>Focus Category:</b>	Management and Planning, Conservation, Water Quality
<b>Descriptors:</b>	geographic information systems, water resources information, data development, education
<b>Principal Investigators:</b>	Bobby J. Creel, John F. Kennedy

## Publication

1. Kennedy, J.F., A. Granados, and R. Aldouri, 2002, Creating a Single Map: Regional Geographic Information System to Support Water Planning in the Paso Del Norte Region. New Mexico Water Resources Research Institute, Technical Completion Report No. 322, New Mexico State University, Las Cruces, NM, 18 pp. and CD.
2. Whitcomb-Thomas, S., 2002, Review of Institutional Governance Structures for Surface Water Treatment Plants for the Lower Rio Grande of New Mexico, New Mexico Water Resources Research Institute Technical Completion Report No. 325, Las Cruces, New Mexico.

### **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 NMWRRRI 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 NMWRRRI 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 NMWRRRI 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. NMWRRRI has been utilized by the NM Interstate Stream Commission to provide GIS mapping products for use in their plans and in public outreach. NMWRRRI 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 WRRRI-funded research activities, is now being used for external research grants (e.g., sources of salinity in the Mesilla Valley and creation of maps for the purpose of water planning funded by the New Mexico Interstate Stream Commission, and the New Mexico Department of Agriculture for pesticide management planning in the state) by water resources management and planning agencies in the state. A recent 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**

The New Mexico Water Resources Research 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. WRRI homepage (<http://wrri.nmsu.edu>) provides on-line information about the institutes newsletters, technical report series, requests for proposals, upcoming conferences and symposia, and the research reference library. Starting with the 44th Annual New Mexico Water Conference Proceedings, all papers have full-text viewing via the institutes homepage. Other federal and state servers, such as the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, USGS, and National Weather Service are linked to the WRRI homepage.

# Information Transfer Program

## Basic Information

<b>Title:</b>	Information Transfer Program
<b>Project Number:</b>	2002NM3B
<b>Start Date:</b>	3/1/2000
<b>End Date:</b>	2/28/2004
<b>Funding Source:</b>	104B
<b>Congressional District:</b>	Second
<b>Research Category:</b>	Not Applicable
<b>Focus Category:</b>	, None, None
<b>Descriptors:</b>	information transfer, information dissemination, education
<b>Principal Investigators:</b>	Bobby J. Creel, Catherine T. Ortega Klett

## Publication

1. Ortega Klett, C.T., (ed) 2002, Proceedings of the 46th Annual New Mexico Water Conference, New Mexico Watershed Management: Restoration, Utilization, and Protection, NM Water Resources Research Institute, Report No. 323, New Mexico State University, Las Cruces, NM, 126 pp.
2. Snell, S. and K. Gregory, 2002, A Flash Flood Prediction Model for Rural and Urban Basins in New Mexico, New Mexico Water Resources Research Institute, Technical Completion Report #321, New Mexico State University, Las Cruces, NM, 40 pp.
3. Kennedy, J.F., A. Granados, and R. Aldouri, 2002, Creating a Single Map: Regional Geographic Information System to Support Water Planning in the Paso Del Norte Region, New Mexico Water Resources Research Institute, Technical Completion Report No. 322, New Mexico State University, Las Cruces, NM, 18 pp. and CD
4. Reiss, R. and P. Guerra, 2002, Genetic Techniques for the Verification and Monitoring of Dihalothane Biodegradation in New Mexico Aquifers, New Mexico Water Resources Research Institute, Technical Completion Report No. 324, New Mexico State University, Las Cruces, NM, 55 pp.
5. Whitcomb-Thomas, S, 2002, Review of Institutional Governance Structures for Surface Water Treatment Plants for the Lower Rio Grande of New Mexico, New Mexico Water Resources Research Institute, Technical Completion Report No. 325, New Mexico State University, Las Cruces, NM, 41 pp. and CD
6. Harris, L.G., L. Blair and C.T. Ortega Klett, 2002, New Mexico Water Rights, New Mexico Water Resources Research Institute, Miscellaneous Report #M15, New Mexico State University, Las Cruces, NM, 49 pp
7. Wood, K, 2002, New Mexico Water Resources Research Institute Five-Year Report 1997-2002, C.T.



Ortega Klett and D.A. Reeves (eds.), New Mexico Water Resources Research Institute, New Mexico State University, Las Cruces, NM, 98 pp.

**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 47 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 late 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 300 technical and miscellaneous reports. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects. Technical reports are available via the WRRRI web site in full text. Those interested in a particular report are available 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 2,100 readers and available on the WRRRI homepage.

The institute averages about 125 requests for general information and more than 30 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 47<sup>th</sup> Annual New Mexico Water Conference was held in October 2002 in Ruidoso, New Mexico. The conference theme, "There's No Doubt, We're in a Drought!" drew over 200 participants. Tours included a visit to the Carrizo Valley Rancho where over 50 tour participants learned of watershed rehabilitation projects conducted on the ranch over the past 40 years. A dozen participants attended a tour of the City of Alamogordo's water treatment plant and storage reservoirs, including a recently installed floating cover on more than 1 million square feet of reservoir water surface area designed to eliminate evaporation losses.

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. The NMWRRI's homepage (<http://wrrri.nmsu.edu>) provides on-line information about the institute's newsletters, technical report series, requests for proposals, upcoming conferences, and the research reference library. Starting with the 44<sup>th</sup>

Annual New Mexico Water Conference Proceedings, all conference papers have full-text viewing on the institute's homepage. Other federal and state servers, such as the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, USGS, and National Weather Service are linked to the NMWRRI homepage.

The institute's publications for the period included 4 technical reports, the 46<sup>th</sup> Annual New Mexico Water Conference proceedings, an update to the popular report "New Mexico Water Rights," the Five-Year WRRI Report, and a map of the Paso del Norte region. NMWRRI technical completion reports are available at no charge while supplies last. A copy charge is assessed 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.

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

**USGS Summer Intern Program**

## Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 RCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	3	0	0	0	3
Masters	6	0	0	0	6
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
<b>Total</b>	10	0	0	0	10

## Notable Awards and Achievements

Project 2000 B-03, 2001 NM1661 Rebecca Reiss, principal investigator. Genetic Techniques for the Verification and Monitoring of Dihalothane Biodegradation in New Mexico Aquifers. Dr. Reiss has been invited to deliver presentations on her work including: Enzyme assays for estimating first-order rate constants of 1,2-dichloroethane biodegradation in groundwater, invited lecture, Water Pollution Conference, 18-21 June, 2003, Cadiz, Spain; Molecular Evolution: Studies in Microbes, Middens, and Man, invited lecture, New Mexicans for Science and Reason, Jan. 8, 2003, Albuquerque, New Mexico; Genomics and Proteomics: Potential Applications in Groundwater Analysis and Bioremediation, invited lecture, American Microbiology Society, Rio Grande Branch Annual Meeting, Feb. 8, 2003, Albuquerque, New Mexico; Genomics and Proteomics: Applications to the Study of Intrinsic Biodegradation, invited lecture, New Mexico Highlands University, March 13, 2003, BRIN distinguished lecture series. Dr. Reiss was awarded a seed grant from the New Mexico State University Waste Education Research Consortium: Development of a Differential Filtration System for Ground Water Analysis. She has submitted an EPA/NSF grant currently under review: NSF - NTE Phase I: Application of Proteomics to Investigate Intrinsic Biodegradation of Dihalothanes. In addition, a student of Dr. Reiss who participated on the USGS funded project, Malinda Stalvey, completed her Environmental Science senior thesis and graduated in May, 2003. She gave a talk on April 30, 2003 at NM Tech entitled: dhIA Gene Detection in Contaminated Aquifers Located in Socorro, New Mexico and Ribera, New Mexico.

## Publications from Prior Projects

1. 2000NM7G ("Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande") - Conference Proceedings - Ward, F., 2002, Economic impacts of drought on uses on the Rio Grande, "in" Proceedings of the 47th Annual New Mexico Water Conference, October 9-11, 2002, New Mexico Water Resources Research Institute, Las Cruces, NM. pp, 39-44.
2. 2000NM7G ("Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande") - Articles in Refereed Scientific Journals - Ward, F. and J.F. Booker, 2003, Economic Costs of Instream Flow Protection for Endangered Species in an International Basin, Journal of the American Water Resources Association, 39(2), 427-440.

3. 2000NM7G ("Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande") - Book Chapters - Booker, J. and F. Ward, 2002, Instream Flows and Endangered Species in an International River Basin, "in" Richard Carson and Linda Fernandez "eds.", Both Sides of the Border: Transboundary Environmental Management Issues Facing Mexico and the United States, Kluwer Publishers
4. 2000NM9B ("The Impact of Heterogeneous Consumer Response on Water Conservation Goals") - Articles in Refereed Scientific Journals - Brookshire, D.S., H.S. Burness, J.M. Chermak, and K. Krause, 2002, Western Urban Water Demand, *Natural Resources Journal*, 42(4)873-898.
5. 2000NM3B ("Genetic Techniques for the Verification and Monitoring of Dihalooethane Biodegradation in New Mexico Aquifers") - Book Chapters - Reiss, R.A., P. Guerra, Enzyme assays for estimating first-order rate constants of 1,2-dichloroethane biodegradation in groundwater, "in" *Water Pollution 2003*, Wessex Institute of Technology Press, in press.
6. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Morales-Morales, H.A., G. Vidal, J. Olszewski, C.M. Rock, D. Dasgupta, K.H. Oshima, and G. Smith, Simultaneous concentration of multiple organisms by hollow fiber ultrafiltration. *App. Environ, Microbiol*, in press.
7. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Kuhn, R.C., C.M. Rock, and K.H. Oshima, 2002, Hollow fiber ultrafiltration of *Cryptosporidium parvum* oocysts from 10L of surface water, *Can. J. Microbiology*, 48, 542-9.
8. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Kuhn, R.C., C.M. Rock, and K.H. Oshima, 2002, The effective recovery of *Cryptosporidium parvum* oocysts using a modified immunomagnetic separation method for concentrated environmental water samples, *Appl. Environ. Microbiology*, 68, 2006-2070.
9. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Widmer, K.W., K.H. Oshima, and S.D. Pillai, 2002, The presumptive identification of *Cryptosporidium parvum* oocysts by artificial neural networks: A novel approach, *Appl. Environ. Microbiology*, 68, 1115-1121.
10. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Kuhn, R.C., C.M. Rock and K.H. Oshima, 2002, Occurrence of *Cryptosporidium* and *Giardia* in wild ducks along the lower Rio Grande River valley, *Appl. Environ. Microbiology*, 68, 161-165.
11. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Winona, L.J., A.W. Ommani, J. Olszewski, J.B. Nuzzo, and K.H. Oshima, 2001, Efficient and predictable recovery of viruses from water by small-scale ultrafiltration systems, *Can. J. Microbiology*, 47, 1033-1041.
12. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Conference Proceedings - Kuhn, R.C. and K.H. Oshima, 2001, Hollow fiber ultrafiltration of *Cryptosporidium parvum* oocysts from 10L of surface water, in *Proceedings of the Water Quality Technology Conference*, American Water Works Association. Nashville, Tennessee, November 2001, CD-ROM.
13. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Olszewski, J., Winona, L.J. and K.H. Oshima, 2001, Two step ultrafiltration process to concentrate virus from environmental water, in *Proceedings of the Water Quality Technology Conference*, American Water Works Association.

Nashville, Tennessee, November 2001, CD-ROM.

14. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Articles in Refereed Scientific Journals - Kuhn, R.C. and K.H. Oshima, 2001, Small-scale hollow fiber ultrafiltration of *Cryptosporidium parvum* oocysts from water, *Water Research*, 35, 2779-2783.
15. 2000NM4B ("Ultrafiltration Based Detection of Viruses and Cryptosporidium Oocysts from Environmental Water Samples.") - Conference Proceedings - Olszewski, J. and K. Oshima, 2001, Small scale tangential flow ultrafiltration of viruses from environmental waters, in Proceedings of the Water Quality Technology Conference, American Water Works Association, Salt Lake City, Utah, CD-ROM.