

**New Mexico Water Resources Research Institute
Annual Technical Report
FY 2016**

Introduction

This annual report provides the required information for projects funded with 2016 USGS 104B base grant and mandatory non-federal matching funds. Please note that there may be some overlap in information with our 2015 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 (NM WRRI) 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. In 2005, the New Mexico state legislature gave NM WRRI statutory authority. 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 NM WRRI 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 dynamic 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 NM WRRI homepage (<http://nmwrri.nmsu.edu/>) provides online information about the institute, newsletters, technical report series, requests for proposals, upcoming conferences and symposia, links to related entities, research reference library, and special projects such as the Statewide Water Assessment. Institute staff are starting to work on a modest redesigned for the website; the website is updated and maintained daily.

New Mexico is one of the driest states in the nation, averaging no more than 20 inches of precipitation a year, varying from about 6.5 inches in the Four Corners area 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 of the annual precipitation other than in the high mountains. Widely varied precipitation contributes as much to a water allocation problem as water scarcity itself. To compound the situation, New Mexico, like much of the West, continues to suffer from the worst long-term drought in 100 years or longer. After several years of severe drought conditions, as of May 2017, only about 20 percent of New Mexico was abnormally dry or in moderate drought status, affecting 40,147 residents, or 2 percent of its total population. The area experiencing dry conditions is located in the sparsely populated southwestern part of the state. Long-term drought persists across the Southwest, and warm and dry weather has further exacerbated regional drought. El Niño helped ameliorate drought conditions in the past year with reservoir storage levels as of May 1, 2017 at about 75 percent of average. Although NOAA is forecasting fairly typical weather for the near future, many forecasters see the drought impacts continuing for a significant amount of time with future water supplies not meeting future water demand in the state.

Additionally, litigation between Texas and New Mexico continues over the apportionment of Rio Grande Project water that supplies irrigators with water in southern New Mexico and El Paso, Texas.

Solving the dire and complex water problems facing New Mexico and the Southwest requires the highest quality research and the NM WRRI is dedicated to assisting in this effort.

Research Program Introduction

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, federal and state agencies, and the USGS Water Resources Research Institute Annual Base Program (USGS 104B).

To make the best use of limited resources, the institute has targeted four areas as high priority for funding: water conservation, planning and management; atmospheric, surface and groundwater relationships; water quality; and utilization of saline and other impaired waters. During the reporting period, six projects received funding from the 2016 Annual Base Program. Four of these projects fit into the water conservation, planning and management category: WRRI Information Transfer Program, Geographic Information System for Water Resources Planning, a Supplemental grant, Drought in the West: Elements of Successful Science to Improve Water Management and Address Nationally Important Issues Through the USGS-NIWR Partnership and a Cooperative Agreement, Transboundary Aquifer Assessment Program (TAAP): NM WRRI Effort Coordination Grant Program. Two water quality projects were supported, New Mexico's Mountain Sources of Water: A Mechanistic Approach to Understand Mountain Recharge and Its Implications for Local and Statewide Water Budgets, and What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?

During the reporting period, March 1, 2016 through February 28, 2017, the NM WRRI administered a total of 53 projects dealing primarily with water planning and management issues as well as water quality. The total value of these projects was \$1,515,634. Dollar amounts per project award ranged from a Student Water Research Grant on groundwater recharge of \$3,194 to a project in the amount of \$150,000 supported by the U. S. Bureau of Reclamation focusing on reducing treatment costs of using alternative waters with antifouling ion-exchange membranes. During the reporting period, 20 projects were conducted at New Mexico State University; 7 at the University of New Mexico; 9 at New Mexico Tech; 2 at New Mexico Highlands University; 2 at Eastern New Mexico University; 3 contracts with 2 private entities and one with the USGS; and two in-house 104B projects (GIS and Information Transfer). NM WRRI staff managed 8 additional projects.

Of the six projects receiving USGS 104B funding during the reporting period, one was made to a New Mexico State University faculty researcher and one to a NM Tech faculty researcher (the other four projects are in-house efforts, i.e., GIS and Information Transfer programs, Drought in the West, and TAAP). The two research grant projects were led by junior faculty at the assistant professor rank.

USGS 104B projects, USGS Supplemental funded project (Drought in the West), and USGS Cooperative Agreement project (TAAP) administered by the NM WRRI utilized 20 students during the year including 7 undergraduates, 6 masters, 4 PhD students, and 3 Post-doc appointees in the disciplines of civil engineering, computer science, environmental engineering, environmental science, finance, geography, hydrology, plant and environmental sciences, public administration, water management, and water resources.

Projects administered by the NM Water Resources Research Institute during the reporting period are listed below. Note that total award value is shown and includes both agency and cost sharing when appropriate, and can include multi-year funding.

Using chloride mass balance to quantify groundwater recharge in the mountains of New Mexico, NM State appropriation, student grant \$3,193

Research Program Introduction

Implementation of drip irrigation system facilitates collaboration between future agricultural leaders, NM State appropriation, student grant \$3,908

Is there a relationship between tree canopy cover change on the landscape and the discharge of Gallinas Creek through time (from 1939 to 2015) in Las Vegas, NM?, NM State appropriation, student grant \$4,720

Investigation of soil composition from burned areas affecting water quality changes following wildfires, NM State appropriation, student grant \$5,550 Effects of ground heat flux on a transitional snowpack in the arid Southwest climate, NM State appropriation, student grant \$5,717

Monitoring water quality parameters within a known range of Western River Cooters (*Pseudemys gorzugi*) within Black River Drainage, NM State appropriation, student grant \$5,772

Spatial prediction of soil hydraulic properties accounting for variable wildfire burn severity, Valles Caldera, New Mexico, NM State appropriation, student grant \$5,793

3D bathymetric model of a shallow lagoon measured by a solar powered low-cost autonomous surface vehicle prototype in Cuauhtemoc, Chihuahua, Mexico, NM State appropriation, student grant \$5,937

How does nutrient processing change along a river continuum? NM State appropriation, student grant \$5,938

Development of a design and calibration manual for simple flow measurement devices in open channel, NM State appropriation, student grant \$5,978

Characterization of Pathogenic Bacterial Regrowth and Impairment Potential along the Rio Grande near Albuquerque, NM State appropriation, student grant \$5,980

Gila National Forest Stream Temperature and Intermittency Monitoring Network for Species of Special Interest, NM State appropriation, student grant \$5,987

Hydro-Weirs: A technology for low-head hydropower generation, NM State appropriation, student grant \$5,990

Potential interactions of turbidity and water velocity on group cohesion in cyprinid fishes from two NM river drainages (Pecos and Canadian Rivers), NM State appropriation, student grant \$5,994

Measuring the impact of rate increases on consumer acceptance of potable water reuse options in the Albuquerque Area, NM State appropriation, student grant \$5,995

Combining empirical relationships with data-based mechanistic modeling to inform solute tracer investigations across stream orders, NM State appropriation, student grant \$6,000

Effects of NRCS and BLM conservation practices on plant and soil biological communities and hydrologic processes in the Rio Puerco Watershed, NM State appropriation, student grant \$6,000

5 cents is still a lot: New generation of anti-bacterial absorbents based on functionalized cellulose aerogels for water treatment in rural areas, NM State appropriation, student grant \$6,000

Uranium abatement for contaminated, limited water resources using clay pellets, NM State appropriation, student grant \$6,000

Research Program Introduction

Post wildfire geomorphic and hydrological effects in the Upper Santa Fe Municipal Watershed, NM State appropriation, student grant \$6,000

Development of calibration procedures for large aperture scintillometers for validation of statewide NM ET maps, NM State appropriation, student grant \$6,000

Aquatic and morphological assessment of the Gallinas River within the Las Vegas, New Mexico city limits, NM State appropriation, student grant \$6,000

Economic performance of water conservation and storage capacity development to adapt to climate in the American Southwest, NM State appropriation, student grant \$6,000

A lab and pilot scale comparison of attached growth and suspended culture for the algal remediation of arsenic from water, NM State appropriation, student grant \$6,000

Developing the water budget and calculating the recharge for the Mesilla Bolson Aquifer, NM State appropriation, student grant \$6,000

Pore-scale transport of strontium and chromate during dynamic water content changes in the unsaturated zone, NM State appropriation, student grant \$6,000

Improved meteorological Infrastructure for water management in the Middle and Lower Rio Grande, New Mexico, NM State appropriation, student grant \$6,000

Solar energy assisted water purification: Incorporation of an environmentally benign porous graphitized carbon nitride (g-C₃N₄) photocatalyst with graphitized polyacrylonitrile (g-PAN) for efficient oxidation of toxic arsenite [As(III)], NM State appropriation, student grant \$6,000

Digital hydrogeologic-framework model of Mesilla Basin Region - Illustration preparation for final review draft of NM WRRI TCR-363, NM State Appropriations, \$10,000

Geographical Information System (GIS) for water resources planning, USGS 104B \$11,413

Information Transfer Program, USGS 104B \$14,522

Transboundary Aquifer Assessment Program (TAAP): NM WRRI effort coordination grant program, USGS Cooperative Agreement, \$19,966

Impact of drought on household water quality in rural Southern New Mexico: Second continuation project, NM Dept of Health, \$20,414

Continued development of the evapotranspiration and recharge model: Focused recharge through ephemeral streams - yr 3, NM State Appropriations, \$29,148

Isotopic and geochemical characterization of deep and shallow groundwater resident time, connectivity, and mixing in the Mesilla Basin, NM, NM State Appropriations, \$29,750

New Mexico's mountain sources of water: A mechanistic approach to understand mountain recharge and its implications for local and statewide water budgets, USGS 104B \$30,000

Research Program Introduction

What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?, USGS 104B \$30,000

Self-sustaining produced water treatment for concurrent renewable energy production, desalination and organic removal, USGS 104B \$30,000

Characterization of produced water in New Mexico- Year 2, NM State Appropriations, \$30,003

Groundwater level and storage change in the Southern High Plains Aquifer in two variably confined aquifers, NM State Appropriations, \$36,026

New Mexico Statewide Water Assessment: Estimation of total available water (TAW) as input for the EvapoTranspiration Recharge Model (ETRM) for statewide ET assessment - Yr 3, NM State Appropriations, \$38,992

Using remote sensing to develop ET fluxes for the Mesilla Valley Aquifer, NM State Appropriations, \$39,249

Chihuahuan Desert Network Administrative Support, National Park Service \$42,275

Gold King Mine Long-Term Monitoring Plan, Information Conference, New Mexico Environment Department, \$48,042

A Dynamic Statewide Water Budget for New Mexico: Yr 3, NM State Appropriations, \$49,557

New Mexico Statewide Water Assessment - Regional equations for estimating mean annual streamflow at ungaged stream locations in NM - Yr 3, NM State Appropriations, \$64,080

Drought in the West: Elements of successful science to improve water management and address nationally important issues through the USGS-NIWR partnership, USGS Supplemental Grant, \$60,000

Biochar for Desalination Concentrate Management cooperative agreement, Bureau of Reclamation-NMSU Cooperative Agreement, \$74,377

Research for the development and use of alternative water supplies, Directed Research, Bureau of Reclamation, \$102,761

Produced water for improving water supply in southeastern New Mexico, New Mexico Environment Department, \$104,711

New Mexico's Experimental Program to Stimulate Competitive Research (EPSCoR) - Social and Natural Science Nexus, National Science Foundation \$140,029

In-situ synthesis of antibacterial ultrafiltration and microfiltration membranes with controllable pore size, Bureau of Reclamation-NMSU Cooperative Agreement, \$149,866

Reducing treatment costs of alternative waters with antifouling ion-exchange membranes, Bureau of Reclamation-NMSU Cooperative Agreement, \$150,000

Drought in the West: Elements of Successful Science to Improve Water Management and Address Nationally Important Issues Through the USGS-NIWR Partnership

Basic Information

Title:	Drought in the West: Elements of Successful Science to Improve Water Management and Address Nationally Important Issues Through the USGS-NIWR Partnership
Project Number:	2015NM184S
USGS Grant Number:	G15AC00329
Sponsoring Agency:	U.S. Geological Survey
Start Date:	7/21/2015
End Date:	7/20/2017
Funding Source:	104S
Congressional District:	NM-2
Research Category:	Climate and Hydrologic Processes
Focus Categories:	Drought, Hydrology, Management and Planning
Descriptors:	None
Principal Investigators:	Alexander G. Fernald

Publications

There are no publications.

Description of problem and research objectives

This project will show how state water institute research addresses nationally important issues. Funding authorized by the Water Resources Research Act (WRRRA) is provided to the National Institutes of Water Resources (NIWR) through the United States Geological Survey (USGS) Water Institutes Program. In some respects, through seeking state-specific goals, the water institutes generate an “invisible hand” that forwards USGS national objectives. However, the direct connections between WRRRA funding and USGS objectives have not been fully demonstrated. An improved characterization of how water institute state based efforts meet regional and national goals is important for justifying and funding the WRRRA.

The Water Resources Research Act (WRRRA) supports research to address national, regional, and state water issues. The WRRRA authorizes four programs: 104B research, 104G competitive grants, internships, and coordination grants. Funding for WRRRA programs is administered through the USGS Water Institutes Program. Of particular interest for this project are 104B and 104G projects. Funding authorized by section 104B of the WRRRA is distributed to the state water institutes to address state and regional water issues. Funding authorized by section 104G is a competitive grant program run through the institutes. The 104G program already is set up to meet national objectives, and is viewed as a success in that regard. The 104B program is set up to meet state water research needs, and even though the state projects meet USGS regional and national objectives, the specific ways in which they meet these broader objectives have not been well documented. Regarding drought, many research projects have been funded to address drought, but the end result of the research is not easily determined.

The Water Institutes Program has a special place in the USGS water area, because the NIWR institutes can be involved in research that results in planning or policy.

The USGS conducts monitoring and research but does not develop policy. No program other than the Water Institutes program in the USGS can directly develop policy in the water arena. There is a huge opportunity space for NIWR to work on programs that connect the dots from science to policy and that include water use as well as supply, thus complementing USGS programs and enhancing NIWR products. Drought, beyond fundamental water scarcity issues, intersects the full array of water management issues in the western U.S., and is an excellent topic to illustrate research impacts.

The goal of this project is to improve the effectiveness of the Water Institutes Program by showing how unique characteristics of the water institutes and their state oriented research help meet regional and national goals. The science question asked is: Research to address drought is funded based on the importance of the issue, but is the science actually implemented in terms of planning and policy for improved water management?

The research objectives are threefold:

- Determine if research produces science that is used for planning
- Identify common elements of successful projects
- Document (tell 3-4 stories) successful inception to completion

Specifically, this project will identify and illustrate representative research projects funded through the WRRRA 104B program that help address the regional issue important to the USGS of drought in the West. To show the end results of the research, this project will identify successful results from 104B funded research after the research has been concluded.

Description of methodology

The methodology includes:

- visits to water institutes located in western states;
- periodic conference calls with Earl Greene, a hydrologist at the U.S. Geological Survey (USGS);
- A search for projects on web and in the literature;
- A search for published papers spawned by research;
- Analyzing science topics and their connection to policy;
- Using the research to write three stories that begin with 104B seed funding and end with an impact on policy.

Description of findings and significance

Findings thus far have proved there are various cases where research projects within the United States began with 104B funding from USGS to address a state issue, and resulted in an impact on policy. The cases provide a direct connection between water science and policy. While 104B funding may have not been the only means of funding for the particular research projects that impacted policy, it is accurate to say that it did allow researchers to begin research to prove the need for more funding after 104B.

The final draft of the policy and management fact sheet was submitted to Earl Greene at USGS January 2017. Dr. Greene expects the policy and management fact sheet to be published by USGS by summer 2017.

New Mexico's Mountain Sources of Water: A Mechanistic Approach to Understand Mountain Recharge and Its Implications for Local and Statewide Water Budgets

Basic Information

Title:	New Mexico's Mountain Sources of Water: A Mechanistic Approach to Understand Mountain Recharge and Its Implications for Local and Statewide Water Budgets
Project Number:	2016NM179B
Start Date:	3/1/2016
End Date:	12/31/2017
Funding Source:	104B
Congressional District:	NM-2
Research Category:	Climate and Hydrologic Processes
Focus Categories:	Climatological Processes, Hydrology, Management and Planning
Descriptors:	None
Principal Investigators:	Jesus D Gomez Velez

Publications

1. Wang C., J. D. Gomez-Velez, and J. L. Wilson (2017), The importance of capturing topographic features for modeling groundwater flow and transport in mountainous watersheds, Hydrology and Earth System Sciences. In prep.
2. Gomez-Velez J.D. (2017), Exploring the Dynamics of Hydrologic Response and Age Distributions, MS Thesis in Applied Mathematics, Mathematics Dept., New Mexico Tech.

Description of problem and research objectives

Recharge is an important component of the water budget, and therefore its quantification at local and regional scales is critical for water resources management under current and future conditions. In semiarid environments, such as New Mexico, mountain recharge represents a significant fraction of the total recharge to basin aquifers. With this in mind, a detailed mechanistic understanding of the "mountain's internal plumbing" is critical to adequately quantify recharge fluxes.

We propose to implement fully-coupled groundwater-surface water, three-dimensional models for four watersheds along a climatic and geologic gradient in New Mexico. These watersheds are located in areas where a significant effort is currently underway to estimate recharge rates within the context of project focusing on a statewide recharge map for New Mexico. These models will be used to quantify mountain recharge and explore the limits of applicability of a parsimonious approach that can be easily applied at regional scales, and therefore support the efforts to estimate a recharge map for the state.

Description of methodology

- We will implement 3-D, fully-coupled groundwater-surface water models for four watersheds along a climatic and geologic gradient in New Mexico and southern Colorado. These high-complexity models will be used to estimate recharge fluxes and compare them with fluxes from the New Mexico recharge map project, an effort funded by the NM WRRRI.
- For each watershed, the high-complexity model will be used as a learning tools to quantify the relative importance of (i) topography and river network structure, (ii) geology, (iii) soil cover and vegetation, and (iv) weather and climate.
- The high-complexity models will be used to project how future climatic change might impact mountain recharge in the state of New Mexico.
- For each watershed, we will implement a simple non-linear, lumped parameter model, which we refer as a parsimonious model, to estimate recharge. The high-complexity models will be used to explore the limits of applicability of the parsimonious model.

Description of principal findings and significance

A no-cost extension until December 31, 2017, was granted to this project. This request allowed Chao Wang, the student funded with this grant, to gain teaching experience as the teaching assistant (TA) for the class HYD 508 Flow and Transport in Hydrologic Systems during the spring of 2017. This is a requirement for our PhD students, and Chao's performance was outstanding, leading to the Best Teaching Assistant award for the academic year.

During the first half of this project, we achieved the following milestones:

- We implement a 3-D, fully-coupled groundwater-surface water model for Rio Hondo watershed. Then, we used this model to explore the importance of generating meshes that capture key topographic features and its implications for mountain recharge, runoff generation, residence times, and solute transport. We found that capturing the river network structure is fundamental to appropriately reproduce the nested network of flow paths observed in mountainous terrains. Due to computational

limitations, these features are typically oversimplified in modeling efforts, resulting in misguided interpretations of observations and biased assessments of water resources, solutes, and contaminants. Our findings have fundamental implications for the interpretation of models in water resources assessments, the use and interpretation of environmental tracers, and the estimation of weathering rates (see attached draft of Wang et al., 2017, in the list of publications).

- We developed the mathematical framework for parsimonious models (see Gomez-Velez, 2017, in the list of publications) and compiled the hydroclimatological information needed for these models.

What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?

What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?

Basic Information

Title:	What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?
Project Number:	2016NM180B
Start Date:	3/1/2016
End Date:	12/31/2017
Funding Source:	104B
Congressional District:	NM-3
Research Category:	Water Quality
Focus Categories:	Agriculture, Irrigation, Water Quality
Descriptors:	None
Principal Investigators:	Kevin A Lombard, April Ulery, David Weindorf

Publications

There are no publications.

What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?

Description of problem and research objectives

Contamination of the Animas and San Juan Rivers following the Gold King Mine blow-out of August 2015 raises a number of questions by farmers in San Juan County as they pertain to agriculture in the watershed. Navajo irrigators residing in San Juan County who access the Hog-back main canal still have elected not to irrigate their farms pending further data. Hay producers and market growers of specialty crops express anxiety over food safety. For example, some farmers have indicated delayed contracts from dairies who purchase baled hay because of fear of heavy metal contamination.

River sediments accumulate in irrigation ditches and smaller laterals. Because the ditches were dry for about 10 days during a closure of the irrigation system, this gave our team the unique opportunity to establish base-line measures of irrigation ditch sediment in dry irrigation ditches for future long-term evaluations of the river/irrigation ditch/agricultural field interface through a repeated measures experimental design.

Description of methodology

Thirteen irrigation ditches in San Juan County from the Colorado border to Farmington, NM were sampled August 11-August 14, during the ban on irrigating crops. Because ditch sedimentation during the irrigation season can vary, at each sample point, we attempted to auger to 18-24 inches (46-70 cm) deep in three separate core pulls (6-8 inches long per core), sampling a cross-sectional transect from one side of a ditch to the other in 2 ft. increments (Figure 1).

Where possible, sample transects were made downstream of a NM Office of the State Engineer (NMOSE) gage station. These gage stations monitor flow data in real time and may provide clues to ditch sedimentation. The following week, three main ditches on the Navajo Nation were sampled. Permission to sample was obtained by ditch companies, the NMOSE, Navajo EPA and Navajo community farm board members.

In one main ditch, we pulled transects at six locations from various points along approximately 15 miles (24 km). This particular ditch became the focus for Sam Fullen's thesis project. Total metals from soil were measured following USEPA method 3051A (USEPA, 1998) using inductively coupled plasma optical emission spectrometry (ICP-OES) analysis. For this study, we narrowed the statistical analysis to arsenic (As) and lead (Pb). Comparisons were performed on estimates obtained from six transect locations along the ditch. For both Pb and As, depths were compared using a mixed model with fixed effects for point category (9 levels), depth (list 3 levels) and their interaction.

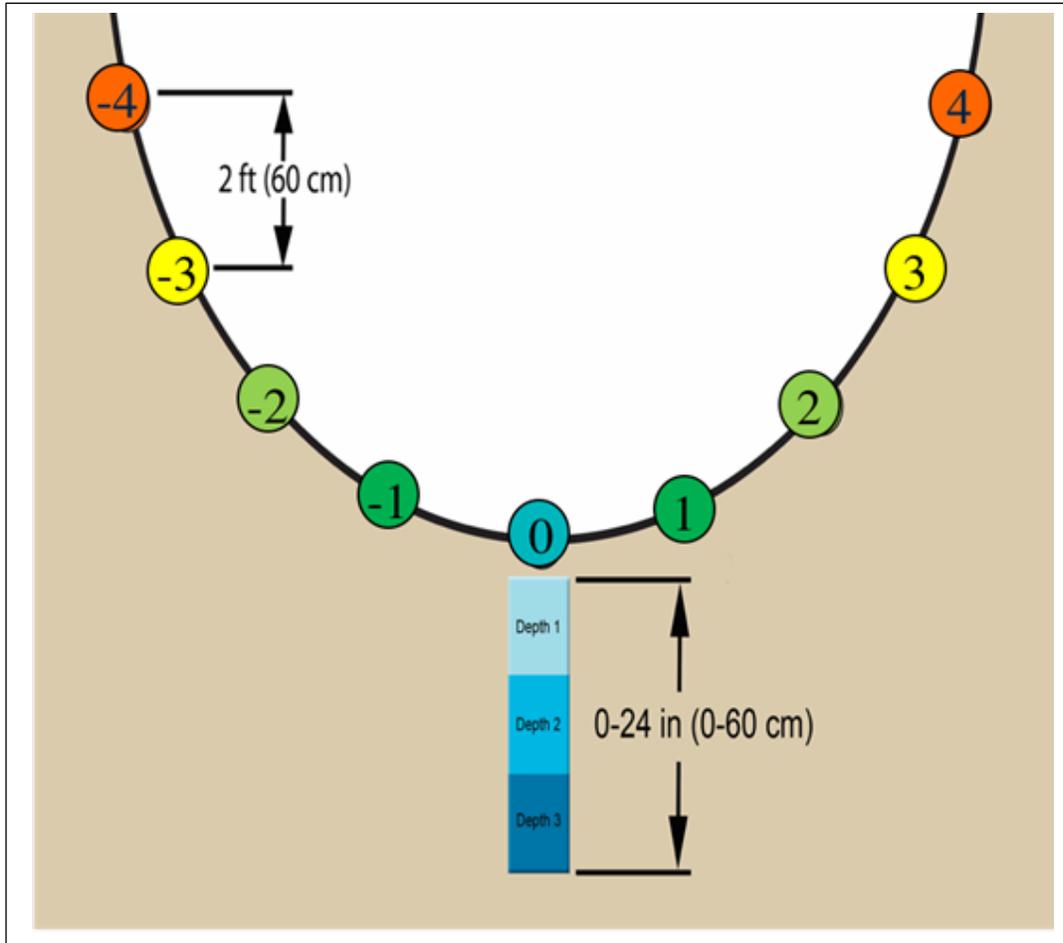


Figure 1. Ditch transect sampling procedure.

Principal findings and significance, and work remaining

Pb Ditch Sediment:

Only depth was significant ($p=0.0017$; point category $p=0.6771$; depth x point category interaction $p=0.1626$) with all depths differing from one another. Lead decreased steadily with estimated lead levels 53.92ppm (\pm a standard error of 6.65ppm), 44.23ppm (± 6.41 ppm), and 27.95ppm (± 4.46 ppm) for depths 1, 2, and 3, respectively. We had a range of lead concentrations from 2.66 ppm to 165.4 ppm, an average of 39.43 ppm, and a median of 29.24ppm. All raw data points and estimates fell substantially below EPA Regional Screening Limits (RSL) for agricultural of 400ppm. This suggests that ditch sediments have not been polluted to the point of requiring intervention for removal.

As Ditch Sediment:

For the As raw data, our range was 4.15 to 26.59 ppm, with an average of 13.96 and a median of 12.87 ppm. Only depth was also found to be significantly different for As ($p=0.0369$; point category $p=0.8525$; depth x point category interaction $p=0.8655$), where depths differ only between the most superficial and deepest depths. Arsenic estimates also decreased in concentration between the top 8" depth at

16.82ppm (± 1.80 ppm) and the deepest 8" depth at 14.47ppm (± 1.93 ppm) [depth 2, at 15.81ppm (± 1.87 ppm), was not significantly different]. All As samples surpassed New Mexico Environment Departments (NMED) sediment arsenic limits of 3.59 ppm. Due to this exceedance of our risk assessment guideline, action might need to be considered reduce As concentrations throughout the ditch, especially if As is exceeding screening limits on agricultural fields. Alternatively, this data may suggest the current risk guidelines are impractical and need reevaluation considering As not only as an anthropogenic pollution from legacy mining, but also influenced by natural geology and environmental factors. San Juan County valley already contains high amounts of geologic arsenic as compared to the NMED risk assessment guideline.

Geographic Information Systems for Water Resources Research Planning

Basic Information

Title:	Geographic Information Systems for Water Resources Research Planning
Project Number:	2016NM182B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	NM-ALL
Research Category:	Not Applicable
Focus Categories:	Drought, Hydrology, Models
Descriptors:	None
Principal Investigators:	Alexander G. Fernald

Publications

1. Ochoa, F., S. Walker, and T.J. Schmutge, 2016, Mapping Evapotranspiration in New Mexico, Report to the New Mexico Water Resources Research Institute, posted at <https://nmwrrri.nmsu.edu/evapotranspiration-years/>.
2. Sabie, R.P., A. Fernald, and M. Gay. 2016. Estimating land cover for three acequia-irrigated valleys using historical aerial imagery. Miscellaneous report submitted to NSF
3. Sabie, R.P. 2016. The feasibility of utilizing produced water to improve water supply sustainability in Southeast New Mexico. Miscellaneous report submitted to NMED

Description of 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 ensure no duplication of effort and to 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.

Description of 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 NM WRI 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 NM WRI maintains a GIS laboratory consisting of computer workstations; data storage devices; input/output devices; software for mapping and analysis (ArcGIS, ENVI); database development and visualization; and network systems. The laboratory is connected via fiber to the New Mexico State University computer network and thereby to the Internet. The NM WRI also maintains an Internet web server site through which both spatial and tabular water resource data can be provided.

Description of 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 has utilized GIS mapping products for use in their regional plans and in public outreach. 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.

The sophisticated mapping and geo-spatial database management system, originally designed to support NM WRRI-funded research activities, has been used for external research grants. This includes the compilation and creation of statewide maps for water planning and budgeting funded by the New Mexico Office of the State Engineer (NMOSE) and the National Science Foundation (NSF), Examination of Mesilla Basin Aquifer Pollution Sensitivity Using DRASTIC for the Border Environment Cooperation Commission (BECC), and Creation of a Digital Hydrogeologic Framework Model of the Mesilla Basin and Southern Jornada del Muerto Basin by water resources management and planning agencies in the state. A research grant has also resulted in the creation of a regional geographic information system to support water planning in the Paso del Norte borderland area of the southwestern United States.

During the reporting period, projects funded through the GIS lab were sponsored by the USGS, BECC, the Experimental Program to Stimulate Competitive Research (EPSCoR) funded by the National Science Foundation, and the National Park Service. The institute provided geospatial analysis to the projects “La Jara Potential Post-Wildfire Debris,” funded by the New Mexico State University Range Improvement Task Force (RITF), and “Estimating Land Cover in Acequia Irrigated Valleys Using Historical Aerial Imagery,” funded through a Coupled Natural and Human National Science Foundation grant. The GIS lab completed three web-mapping applications for a New Mexico Environment Department funded project, “The Feasibility of Utilizing Produced Water to Improve Drinking Water Supply in Southeastern New Mexico.”

The EPSCoR statewide water budget for New Mexico is an ongoing project with new data continually being added to the database and assistance being given to produce specific GIS products upon request. The GIS lab also provided geospatial support for graduate students measuring evapotranspiration through EPSCoR and a USGS funded Transboundary Aquifer Assessment Program. There is an ongoing effort to improve evapotranspiration estimates in New Mexico in collaboration with USGS and NASA scientists. The results of this work are being implemented into a system dynamics model to better understand the state’s water availability. Continued funding is anticipated from annual state appropriations as well as pending agency awards.

Transboundary Aquifer Assessment Program (TAAP): NM Water Resources Research Institute Effort

Basic Information

Title:	Transboundary Aquifer Assessment Program (TAAP): NM Water Resources Research Institute Effort
Project Number:	2016NM190S
USGS Grant Number:	G16AC00428
Sponsoring Agency:	U.S. Geological Survey
Start Date:	3/1/2016
End Date:	8/1/2017
Funding Source:	104S
Congressional District:	NM-2
Research Category:	None
Focus Categories:	
Descriptors:	None
Principal Investigators:	

Publications

1. Milanés-Murcia, M., 2017, Chapter 5 "Proposed International Legal and Institutional Framework for Conjunctive Management of Surface and Groundwater along the U.S. Mexico Border Region." In the book "Management of Transboundary Water Resources under Scarcity: A Multidisciplinary Approach," World Scientific Publishers.
2. Milanés-Murcia, M. Chapter 11 "International Principles of Groundwater Law. An Analysis of Groundwater Rights [...]" In Handbook on International Water Law. Edward Elgar Publishing (ed. McCaffrey and Leb) (forthcoming in Fall 2017).
3. Milanés-Murcia, M. "The U.S.-Mexico Transboundary Aquifer Assessment Act, 2006. Cooperation between the U.S. and Mexico, Achievements, Current and Future Efforts in the Mesilla Aquifer Basin." Natural Resources Journal (submitted June, 2017).
4. Milanés-Murcia, M. "History and Current International Water Legal Framework of the United States-Mexico Border." American Journal of International Law (submitted June, 2017).

Description of problem and research objectives

This research is part of a larger effort associated with the Transboundary Aquifer Assessment Program (TAAP). Three major research efforts will be undertaken by NM WRRRI to better understand the Mesilla Basin priority transboundary aquifer: 1) Geochemical and isotopic determination of deep groundwater as a source of discharge and salinity to the shallow groundwater and surface-water systems, Mesilla Basin, NM, TX, and Mexico; 2) Remote sensing to develop ET Fluxes for the Mesilla Valley Aquifer; and 3) Effects of changing water availability on riparian vegetation habitat and water use in the Mesilla Valley Basin Aquifer, NM.

TAAP efforts concerning the Mesilla-Conejos Medano Aquifer by the NM WRRRI and New Mexico State University are in collaboration with the U.S. Geological Survey and the International Boundary and Water Commission/CILA (Mexican counterpart).

Description of methodology

The New Mexico scientific assessment, headed by NM WRRRI Director Sam Fernald, will continue development of the Mesilla-Conejos Medanos Aquifer Model, support research to improve groundwater understanding, and provide coordination between US and Mexico regarding the Mesilla-Conejos Medano Aquifer. Work to date has focused on:

- Data collection
- Geophysical and geochemical investigation
- Expanded hydrogeologic framework
- Data exchange between US and Mexico
- Groundwater model – improvements to 2007 model
- Developed the Farm Process for surface water interactions with groundwater

Current USGS Programs being utilized include: 1) Rio Grande Transboundary Integrated Hydrologic Model and 2) Mesilla Basin Monitoring Network and include:

- Collection of 20 groundwater samples for several isotope analyses to evaluate groundwater age, connectivity, mixing, and recharge.
- Sampled and analyzed groundwater samples for ultratrace dissolved noble gas isotopes.
- Measurement of ET using Eddy Covariance System (3D-Sonic anemometer, LiCoR hygrometer, net radiation, relative humidity/air temperature, soil heat flux plates, soil moisture and temperature); measured microclimate and depth to groundwater (solar radiation; windspeed/direction; relative humidity/temperature; precipitation; soil temperature; and depth to groundwater)
- Set-up of climate station for reference ET; the station will collect data for long-term monitoring of climate (in collaboration with New Mexico State Climatologist Dr. David Dubois and NMSU Leyendecker Plant Research Center under the direction of Dave Lowry. EPSCoR (Experimental Program to Stimulate Competitive Research) is providing funding for climate station.

- Produced ET Map for 2015 for the Mesilla Valley, calculated with remote sensing; this provides spatial ET for water budgets and modeling (A conference on NM ET will be held June 6-7, 2017 at the Las Cruces Convention Center)
- Designed a remote sensing approach
- Established a study site in Radium Springs, NM to the New Mexico/Texas border that overlies the Mesilla Aquifer basin; a review of aerial photos of the Lower Rio Grande with Landsat imagery can be used to detect NDVI (normalized difference vegetation index), a vegetation index
- Landsat imagery were calculated using NDVI for 5-year increments
- Produced satellite imagery and Landsat maps comparing riparian vegetation before and after drought
- Used object-oriented image analysis (OBIA) to get more precise riparian sizes.

Description of principal findings and significance

Project coordination efforts will continue with a planned 2017 fall meeting at which New Mexico will share the latest model information including:

- USGS Groundwater Model – Surface water operations focus
- Office State Engineer Groundwater Model – Surface-groundwater interaction focus
- NM WRRRI Evapotranspiration Models – Applicability to Mexico and Texas

The meeting will also focus on establishing data sharing objectives and discussion of the binational groundwater model of Mesilla/Conejos Medanos. CILA/IBWC, NM WRRRI, and USGS will participate. Discussion will start with goals specific to the binational situation with an emphasis on binational model parity.

Several presentations on the TAAP program were planned for May and June 2017 including the presentation at the 2017 World Water Congress in Cancun, and the 2017 UCOWR/NIWR annual conference. A book chapter, *International Principles of Groundwater Law. An Analysis of Groundwater Rights [...] in Handbook on International Water Law*, will be published in the fall of 2017, and two journal articles have been submitted in the *Natural Resources Journal* and the *America Journal of International Law*.

In summary, the TAAP has launched an incredibly valuable border region initiative that includes: state water institute and federal USGS science center collaboration, US and Mexico counterpart collaboration on data collection, new frameworks for US and Mexico cross-border information sharing and hydrologic modeling, an effort for a new binational groundwater model of the Mesilla Basin Aquifer between New Mexico and Mexico, and the start of a process for a border-wide regional groundwater summit in 2018, that will be discussed at a World Water Congress meeting in Mexico in late May 2017. TAAP supports vital on the ground research in New Mexico on water budgets, groundwater hydrology, riparian area water use as affected by drought, and evapotranspiration modeling.

Information Transfer Program Introduction

The New Mexico Water Resources Research Institute maintains an active program to transfer technical information from the producer to the user and the public. The institute's website, technical publications, newsletters, conferences, symposia, press announcements, and presentations keep practitioners aware of new water-related technology and research advances. The NM WRRI homepage (<http://nmwrrri.nmsu.edu/>) provides online information about the institute's programs, newsletters, technical report series, requests for proposals, upcoming conferences and symposia, the research reference library, and special in-house projects. Of the past 61 annual water conferences, 58 conference proceedings have full-text viewing via the institute's homepage and others are in preparation; recent water conference speaker slides are available on the conference website. New Mexico universities, federal and state servers, including the NM Office of the State Engineer, the USGS, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, Bureau of Reclamation, and National Climatic Data Center are linked to the NM WRRI homepage.

Information Transfer Program

Basic Information

Title:	Information Transfer Program
Project Number:	2016NM181B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	NM-ALL
Research Category:	Not Applicable
Focus Categories:	Education, None, None
Descriptors:	None
Principal Investigators:	Catherine T. Ortega Klett

Publications

1. Herrington, C. and R. Gonzalez-Pinzón, 2016, Doing Hydrology Backwards in New Mexico to Estimate a Statewide Water Budget. New Mexico Water Resources Research Institute, Technical Completion Report No. 371, New Mexico State University, Las Cruces, New Mexico.
2. Stringam, B., M. Shukla, and B Nana O Kuffour, 2016, Assessment of Water Table and Water Quality Variations with Respect to the River Flow Along the Rio Grande Between Garfield NM and the New Mexico Texas Border. New Mexico Water Resources Research Institute, Technical Completion Report No. 372, New Mexico State University, Las Cruces, New Mexico.
3. Xu, P. and Z. Stoll, 2016, Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal. New Mexico Water Resources Research Institute, Technical Completion Report No. 373, New Mexico State University, Las Cruces, New Mexico.
4. Foudazi, R. R. Zowada, and A. Malakian, 2016, Arsenic Removal from Water by Porous Polymers. New Mexico Water Resources Research Institute, Technical Completion Report No. 374, New Mexico State University, Las Cruces, New Mexico.
5. Cather, M., C. Gallegos, and D. Chen, 2016, Accessing Produced Water Data in New Mexico: Improving and Updating the NM Produced Water Quality Database and Web Site. New Mexico Water Resources Research Institute, Technical Completion Report No. 375, New Mexico State University, Las Cruces, New Mexico.
6. McCarville, D.C., M.P. Bleiweiss, and S. Bawazir, 2016, Classification of Riparian Saltcedar in the Desert Southwest Using Landsat Data and the HANTS Algorithm. New Mexico Water Resources Research Institute, Miscellaneous Report No. M32, 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, including the state's policy makers, 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 agencies and 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 the institute's website, conferences, publications, and audio/visual presentations. For the past 61 years, the NM WRI has sponsored the Annual New Mexico Water Conference focusing on a topic of importance to the New Mexico water community, usually policy oriented. The annual conference is held in different locations around the state 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 150 and 200 people, depending on the location and topic of the conference. The 2015 conference had nearly 262 participants, and the most recent conference had 183 in attendance. The 2016 conference was held in the southwestern part of the state, a site that had never hosted the annual conference before. For the past six years, the annual water conference has included a poster session, which highlights water research taking place across the state and region. Students are encouraged to present posters at the annual water conference and in 2016, 23 students did so. NM WRI funded 16 Student Water Research Grants in 2016, and most of the recipients attended the annual water conference and presented a poster.

The NM WRI was asked by the New Mexico Environment Department to coordinate a conference that would facilitate the exchange of data and research results associated with monitoring efforts related to the August 2015 Gold King Mine spill. The institute worked with a multi-agency planning committee to host a conference on the *Environmental Conditions of the Animas and San Juan Watersheds with Emphasis on Gold King Mine and other Mine Waste Issues*. The conference took place at San Juan College in Farmington, NM on May 17-18, 2016. Over 150 participants took part in a two-day meeting that featured technical oral and poster presentations and a panel discussion that was open to the public at no charge. Due to the success of the conference, the U.S. Environmental Protection Agency has provided funding to the NM WRI through the New Mexico Environment's Long-Term Monitoring Plan: Evaluating the Effects of the Gold King Mine Wastewater Spill in Northern New Mexico to host the conference in 2017 and 2018. Plans for the June 20-22, 2017 conference are underway and this year's conference will include a one-day field trip that will explore the geology, mining, agriculture,

and water resources issues in the Animas River and San Juan watersheds of northern New Mexico and southwestern Colorado.

Publications include technical completion reports resulting from NM WRRI-sponsored projects, special in-house publications, and conference proceedings. The institute has published more than 400 technical and miscellaneous reports. The peer reviewed technical completion reports are directed toward water professionals working in disciplines related to the research projects. All technical reports are available via the NM WRRI website 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. NM WRRI water conference proceedings for the past 58 years are also available online in full text. In recent years, water conference speaker slides are posted on the conference website with the permission of the speaker.

In 2015, the institute began producing a monthly newsletter via email, “New Mexico Water eNews.” The online news feed reaches about 1,530 recipients each month and keeps its recipients informed of NM WRRI activities, upcoming meetings, publications, and research projects.

The institute-housed reference room underwent a major reorganization. All books and documents were checked for online availability; for books found to be available online, the institute’s online library database was noted with the link. A complete catalog of holdings, 8,852 books and references, can be searched through the NM WRRI website, reference room link at <https://nmwrri.nmsu.edu/reference-room/>, accessible by faculty, students, and the general public.

NM WRRI’s homepage (<https://nmwrri.nmsu.edu/>) provides online information about the institute’s newsletters, technical report series, requests for proposals, upcoming programs, special in-house projects such as the Statewide Water Assessment, and the research reference library. All NM WRRI reports are available for viewing online via the institute’s website. The website, originally created in 1995, has undergone a complete redesign and was launched in the summer of 2015; the website is currently undergoing another redesign. The website is updated on a regular basis and continues to be a focal point of information on New Mexico’s water resources with many links to other related sites such as the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, USGS, Bureau of Reclamation, and National Climatic Data Center. For the reporting period, the NM WRRI website received 42,096 unique visits.

NM WRRI has developed a state-of-the-art geographic information system on water resources in New Mexico and has become the focal point for GIS data and information concerning water resources in the state. It combines database management with digital mapping into spatial-tabular data models. These models are powerful tools for representing and manipulating earth-science information. The primary objective of the system is to increase availability and accessibility of water resource information to support water resource planning and management in the state. Efforts are coordinated with cooperating agencies and organizations to ensure no duplication of effort and to establish guidelines for map coverages and priorities. The staff maintains, updates as necessary, and makes the data available to cooperating agencies and organizations through both formal and informal arrangements to facilitate water resource planning activities. In recent years, the NM WRRI has provided GIS expertise on a regular basis to the National Park Service.

The institute director is 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 director also contributes to proposal development on funding opportunities; many of these proposals are interdisciplinary, multi-university efforts.

Accomplishments

The 61st Annual New Mexico Water Conference was held in Silver City on October 5-7, 2016. The conference theme was *Where Does All the Water Go? History, Hydrology and Management of New Mexico's Scarce Waters*. The conference brought together the state's water community to discuss managing all aspects of the state's waters. A highlight of the conference was former U.S. Senator Jeff Bingaman's presentation, *Rethinking Western Water Management*. Senator Bingaman was honored to give the 2016 Albert E. Utton Memorial Water Lecture. The 2016 conference was attended by 183 participants and included 40 posters, of which 23 were presented by students. PowerPoint presentations made at the conference are available on the institute's website. The conference proceedings is in preparation and will be posted on the website.

Five Technical Completion Reports were published during the reporting period:

Doing Hydrology Backwards in New Mexico to Estimate a Statewide Water Budget by C. Herrington, RG Pinzón, University of New Mexico (March 2016)

Assessment of Water Table and Water Quality Variations with Respect to the River Flow Along the Rio Grande Between Garfield NM and the New Mexico – Texas Border by B Stringam, M Shukla, B Nana O Kuffour, New Mexico State University (April 2016)

Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal by P Xu, Z Stoll, New Mexico State University (July 2016)

Arsenic Removal from Water by Porous Polymers by R Foudazi, R Zowada, A Malakian New Mexico State University (October 2016)

Accessing Produced Water Data in New Mexico: Improving and Updating the NM Produced Water Quality Database and Web Site by M Cather, C Gallegos, D Chen, New Mexico Tech (October 2016)

One Miscellaneous Report was published:

Classification of Riparian Saltcedar in the Desert Southwest Using Landsat Data and the HANTS Algorithm by DC McCarville, MP Bleiweiss, S Bawazir (May 2016)

For the past year, the institute's website has averaged 3,508 unique online visits each month. It averages 1,868 online unique visits for publications from its technical and miscellaneous report series and an average of over 15,381 unique visits and pdf downloads per month of its proceedings series. Because of the ability to view and print all institute publications online, the

NM WRRI is averaging only a few requests for hard copies of specific publications each month via postal mail or visits to the institute. Requests online have continued to increase each year.

In order to get water-related information out more quickly and efficiently, the NM WRRI began an online news feed in March 2015, New Mexico Water *eNews*. Each month the institute emails the online newsletter to about 1,530 recipients with an average open rate of 26 percent each month. The news feed aims to keep its readers informed on the latest water topics, emphasizing those in which the NM WRRI is involved.

Online unique visits per month of the NM WRRI's reference room averaged 90 for the reporting period. One student and a part-time institute staff member continued the reorganization of the institute-housed water reference room. The initial review of books has been completed and cataloging is underway for the 3,210 holdings housed at the institute. Books previously housed at the institute, but which are now online, are noted on the institute's online library database with a link – 5,642 books are linked this way. A complete catalog of holdings, 8,852 books and references, can be searched through the NM WRRI website reference room link at http://nmwrri.nmsu.edu/?page_id=2897.

The institute's director participates in local, state, and national conferences and workshops and speaks before many groups. He is President-Elect of the National Institutes for Water Resources and as part of his duties, he and his staff hosted the NIWR Annual Meeting in Washington DC on February 27-March 1. He is the chair of the NIWR-USGS Partnership Committee. The director is also a member of the Universities Council on Water Resources and serves on their board. Recently, the director was elected to the Western Regional Big Data Steering Committee. He was also recently selected to serve on the Chihuahuan Desert Rangeland Research Center Steering Committee. The director also serves on the STATEMAP Advisory Committee, a statewide committee recently working on support to the USGS for geologic mapping in New Mexico.

The NM WRRI 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, particularly in the Paso del Norte area. The institute also coordinates meetings for the Lower Rio Grande Water Users group that consists of New Mexico State University, City of Las Cruces, Doña Ana County, New Mexico Pecan Growers Association, Elephant Butte Irrigation District, Public Service Company of New Mexico, Camino Real Regional Utility Authority, and Southern Rio Grande Diversified Crop Farmers Association.

The director works on legislation impacting the NM WRRI at both the state and national levels. This year the director gave a presentation to the New Mexico Legislature House Agriculture and Water Resources Committee to update committee members on the institute's programs and to request financial support for continuing work on the Statewide Water Assessment initiative. At the national level, particularly as a Board member for the National Institutes for Water Resources, the director met with New Mexico U.S. Senators and Representatives on the reauthorization of the Water Resources Research Act and FY18 appropriation.

The New Mexico State Legislature held a 60-day session in early 2017 and wrestled with a very tight state fiscal budget that was impacted by falling revenues in the oil and gas industry and slow recovery from the 2008 recession. In late May 2017, the Governor of New Mexico called the State Legislature back to a Special Session to continue working on balancing the state budget. As a result, NM WRRI had its base budget reduced; since FY16, its base budget has been reduced by nearly 10%. The base budget of recurring funds supports operations of the NM WRRI and water research throughout the state including faculty and student grants to NM universities. During the past three years, the NM WRRI has received \$500K from the New Mexico Office of the Attorney General with funds from the Consumer Settlement Fund. These one-time funds have supported NM WRRI special projects, like the Statewide Water Assessment effort that aims to improve water management in New Mexico. In the May 2017 Special Session, the Governor vetoed \$500k from the Water Conservation Fund that would have provided funding to the institute for the continuation of the development of the Statewide Water Assessment.

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

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	6	0	0	1	7
Masters	4	0	0	2	6
Ph.D.	4	0	0	0	4
Post-Doc.	2	0	0	1	3
Total	16	0	0	4	20

Notable Awards and Achievements

Several awards were received associated with the 104B grant, "Self-sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal." The grant was awarded to Dr. Pei Xu at NMSU and was one of two projects highlighted in the National Institutes for Water Resources 2017 NIWR Fact Sheet, which was distributed broadly including to U.S. Congressional members. Dr. Xu's research was an example of the innovative projects funded by 104G and the projects' tremendous impact on research and practical application nationwide. Further, Dr. Xu's PhD student on the project, Zachary Stoll, received 3rd Place in the Fresh Ideas Poster Competition at the AWWA's Annual Conference & Exposition in June 2016. The poster, "Feasibility and Techno-Economic Analysis of Microbial Fuel Cells for Energy Positive Wastewater Treatment," also received a First Place for Best Poster at the RMSAWWA/RMWEA 13th Annual Student Conference held May 2016 in Laramie, Wyoming. The poster was also presented at four other meetings including NM WRRRI's 59th Annual New Mexico Water Conference. The project has resulted in four journal articles to date along with an NM WRRRI technical completion report.

Dr. Kevin Lombard and several students participated on the 104B grant, "What are the effects of the Gold King Mine spill on San Juan County, NM agricultural irrigation ditches and farms?" Dr. Lombard and his students presented project results at several meetings and were highlighted in a newspaper article, "Scientists gather, share early findings of Gold King Mine spill monitoring," published on 05/25/2016 by NMSU writer, Jane Moorman. The funding for this project leveraged funding for Gold King Monitoring by the U.S. Department of Agriculture/Natural Resources Conservation Service and from the New Mexico Environment Department/U.S. Environmental Protection Agency.

Dr. Jesus Gomez-Velez's doctoral student on his project, "New Mexico's Mountain Sources of Water: A Mechanistic Approach to Understand Mountain Recharge and Its Implications for Local and Statewide Water Budgets," was awarded the Outstanding Teaching Award for the Dept. of Earth & Environmental Sciences. New Mexico Tech PhD candidate Chao Wang received the honor for the 2016-17 Academic year.

Dr. Gomez-Velez's 104B grant also resulted in an added course at NM Tech: HYD 520/GEOP 520/MATH 583 Data-driven Modeling in Science and Engineering. This course introduces students to statistical learning techniques and data assimilation for science and engineering applications. Given the wide variety of topics, the course focuses on practical applications and emphasizes the understanding of the assumptions underlying different techniques. This approach allows students to learn the basics of useful tools for data-driven modeling and revisit their theoretical and practical underpinnings as needed. Topics may include supervised and unsupervised learning, regression, classification, importance sampling, ensemble forecasting, and Kalman Filtering. The codes R or Python will be used for the class.

New Mexico State University's Water Science and Management (WSM) program currently has 31 master's and PhD students enrolled in the program, representing 10 countries. Seventeen students have graduated from the program since its first graduating class in 2013. The program has increased enrollment in graduate education, increased water research, and offers doctoral level courses in the departments of civil engineering, geography, plant and environmental sciences, agricultural economics/agricultural business, and animal and range sciences. The EnerGIS scholarship committee selected Hugo Rojas Villalobos, an NMSU doctoral candidate in the WSM program, as the graduate grand prize winner of a \$1,000.00 scholarship. Villalobos will present his research at the EnerGIS 5th Annual Conference in June in Canonsburg, Pennsylvania. Margie Vela, a doctoral candidate in the WSM, was appointed by Governor Susana Martinez as the NMSU Student Regent for a two-year term.

New Mexico State University Professor Manoj Shukla, former recipient of a 104B award, "Land Application of Industrial Effluent on a Chihuahuan Desert Ecosystem: Impaction Soil Physical and Hydraulic Properties,"

received a recent one-year grant associated with the Cooperative Agreement between the Bureau of Reclamation and New Mexico State University, "Research for the Development and Use of Alternative Water Supplies." This collaborative project will help increase scientific knowledge and research expertise in the area of characterization, treatment, and use of alternative waters for water supply sustainability in New Mexico and the western U.S. Dr. Shukla's grant is entitled, "Irrigation with Brackish Groundwater and Desalination Concentrate: Effect on Soil Microbial Properties, Plant Uptake and Ion Deposition in Soil."

A 104B grant, "Understanding the Costs of Arid Inland Communities' Potable Water Reuse Options," provided funding to PhD student Jason Herman who graduated with distinction in Spring 2017. Jason was supervised by University of New Mexico PI Caroline Scruggs on the project.

Publications from Prior Years

1. 2014NM166B ("Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal") - Water Resources Research Institute Reports - Xu, P. and Z. Stoll, 2016, Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal. New Mexico Water Resources Research Institute, Technical Completion Report No. 373, New Mexico State University, Las Cruces, New Mexico.
2. 2014NM166B ("Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal") - Articles in Refereed Scientific Journals - Ma, Z., H. Song, Z.A. Stoll, and P. Xu, 2017, Melamine modified carbon felts anode with enhanced electrogenesis capacity toward microbial fuel cells. *Journal of Energy Chemistry*, 26, 81-86.
3. 2014NM166B ("Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal") - Articles in Refereed Scientific Journals - Stoll, Z.A., Z. Ma, C.B. Trivedi, J.R. Spear, and P. Xu, 2016, Sacrificing power for more cost-effective treatment: A techno-economic approach for engineering microbial fuel cells. *Chemosphere*, 161, 10-18.
4. 2014NM166B ("Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal") - Articles in Refereed Scientific Journals - Stoll, Z.A., J. Dolfing, Z. Ren, and P. Xu, 2016, Interplay of anode, cathode and current in microbial fuel cells: implications for wastewater treatment. *Energy Technology*, 4(5), 583-592.
5. 2014NM166B ("Self-Sustaining Produced Water Treatment for Concurrent Renewable Energy Production, Desalination and Organic Removal") - Articles in Refereed Scientific Journals - Stoll A.Z., C. Forrestal, Z. Ren, and P. Xu, 2015, Shale Gas Produced Water Treatment Using Innovative Microbial Capacitive Desalination Cell. *Journal of Hazardous Materials*, 283, 847-855.
6. 2015NM176B ("Arsenic Removal from Water by Porous Polymers") - Water Resources Research Institute Reports - Foudazi, R., R. Zowada, and A. Malakian, 2016, Arsenic Removal from Water by Porous Polymers. New Mexico Water Resources Research Institute, Technical Completion Report No. 374, New Mexico State University, Las Cruces, New Mexico.
7. 2010NM123S ("Monitoring and Forecasting Climate, Water, and Land Use for Food Production and Business Development in Iraq") - Articles in Refereed Scientific Journals - Shokhrukh-Mirzo Jalilov, M. Keskinen, O. Varis, S. Amer, F.A. Ward, 2016, Managing the water energy food nexus: Gains and losses from new water development in Amu Darya River Basin, *Journal of Hydrology*, 53:648-661.
8. 2013NM171S ("Groundwater Exploration, Assessment and Monitoring for Humanitarian Assistance in Ethiopia") - Articles in Refereed Scientific Journals - Befekadu G., H. Habteyes, A.E. Hasseen El-bardisy, S.A. Amer, V.R. Schneider, and F.A. Ward, 2015, Mutually beneficial and sustainable management of Ethiopian and Egyptian dams in the Nile Basin, *Journal of Hydrology*, 529:1235-1246.
9. 2010NM123S ("Monitoring and Forecasting Climate, Water, and Land Use for Food Production and Business Development in Iraq") - Articles in Refereed Scientific Journals - Obeed Al-Azawia, A.A. and F.A. Ward, 2016, Groundwater use and policy options for sustainable management in Southern Iraq, *International Journal of Water Resources Development*, <http://dx.doi.org/10.1080/07900627.2016.1213705> 2016.1213705