Divining Rod
Vol. XXXIII, No. 2 • July 2010

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Abating Uranium Contamination in Four Corners Area Groundwater

by Will Keener, WRRI

When Antonio Lara, Assistant Professor in New Mexico State University's Chemistry and Biochemistry Department, learned that student Nick Beltran was from Gallup, New Mexico, he had a project for him. Throughout the Four Corners area on and off the 27,000-acre Navajo Reservation, a legacy of earlier uranium mining in the area has left uranium-contaminated groundwater, presenting serious problems for the health of residents.

Nick Beltran (left) and Professor Antonio Lara discuss some recent data recorded during experiments. Lara's emphasis on the uranium work and other projects is to provide community-based solutions to problems.

"Professor Lara suggested the uranium problem," Beltran recalls. "Although I was somewhat familiar with the mining, I didn't know about the water situation. Dr. Lara is very attracted to research that benefits communities. What we are working on is an appropriate technology that people can understand and use. It's a local solution to a problem."

Uranium is a natural element that can be found everywhere. However, mining activities can increase human exposure. Processing and transporting ore during various weather conditions – windy and rainy weather – can mobilize uranium

Divining Rod

Published by
The New Mexico Water
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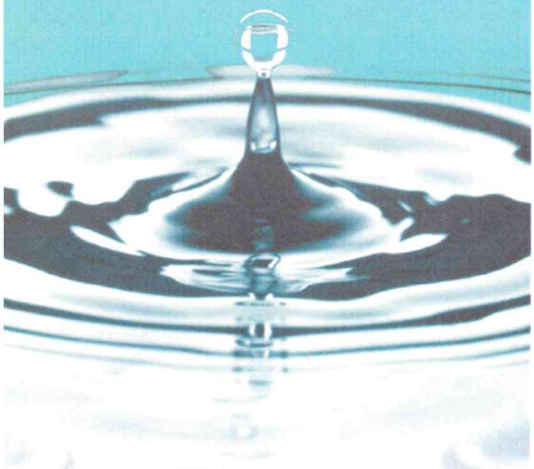


particles. These particles can combine with the rainwater and migrate into the groundwater.

With a research grant from the Water Resources Research Institute, Lara and Beltran designed experiments and gathered data to provide a proof of concept on a relatively low-tech, low-energy approach to cleaning up the groundwater.

The project involves the use of phyllosilicates found in common clays around New Mexico to capture the uranium ions in contaminated water. The phyllosilicates, or sheet silicates, have a unique structure that allows them to capture metallic ions in solution. When uranium-containing water contacts the clay, an exchange of one positively charged uranium ion in solution for two positively charged sodium ions in the clay occurs.

In the experiments, uranium solutions of known concentrations are introduced to clay pellets on the test-tube scale. One experiment showed that the uranium concentration decreased from 500 to 132.4 parts per billion (ppb) in the first fifteen minutes. The clay reduced concentrations to below EPA's safe drinking water limit of 30 ppb within the next hour and a half. The final uranium concentration was 1.5 ppb after eight hours of exposure to the layered phyllosilicates.

"It takes some time to get to that point, and that's one of the things we're still addressing," says Beltran. "But the process is very simplistic, with low energy requirements."

The research team is using two key tools to study the uranium abatement process and find opportunities to optimize it. The inductively coupled plasma mass spectrometer can determine the presence of uranium isotopes at the parts per billion level, Beltran explains. It takes an accurate snapshot of the water sample at a point in time. Another instrument, the luminescent spectrometer, can track changes over time, although only in the parts per million concentration range.

"As the abatement takes place, we can see the charged uranium quickly concentrates around the sorbent (clay particles), but the ion exchange moves slower," says Beltran.

The researchers are testing different clays as opportunities arise, but so far the type of clay hasn't mattered. "We see brown clays from near Berino and red clays from around Gallup, but the structures are similar and both seem to work equally well," says Beltran.

Team members are studying water pH, uranium concentrations, exposure times to the clay, and other variables in bench-scale tests to better understand the process. Right now, the team describes the uptake of uranium by the clay as "sorbing." This is a term that describes potential mechanisms that may be at work – adsorption or absorption, says Beltran. "The next step is to do kinetic and thermodynamic studies to determine what actually goes on inside the clay and then propose models that will improve the sorption design."

"The use of clay to abate uranium is only one potential application," Lara explains. "We will be working with one element at a time, but there is

no reason to have heavy metals in drinking water with this approach. It's an appropriate level of technology." Lara has reached out to affected communities by establishing a relationship with researchers at Dinè Community College at Shiprock, New Mexico. When Dinè Environmental Institute Director Marnie Carrol and a Dinè College student arrive on the NMSU campus in late July, Lara, Beltran and the team will work with them to help analyze soil and water samples collected on the Navajo Reservation. This outreach is critical, says Beltran. The problem threatens to become worse, as attention on U.S. uranium supplies becomes more intense and mining companies again eye potential mining sites in the Four Corners region.

By proving that the concept works and demonstrating it at a community scale, Beltran is hopeful that mining companies as well as local governments will adopt the process.

Members of the research team have included several NMSU undergraduates: Jesus Martinez, biology; Raymundo Chavira, genetics; Vanessa Begay, biology; Amanda Munoz, biochemistry; David Kimball, biology; William Bradley, chemical engineering; Rich Eriacho, chemistry; and Diane Shelby, animal and range science.

Most of the team members have become involved in the uranium project through the Bridge Program, which promotes the education of Native American students in biomedical research, and the NMSU RISE to Excellence Program. RISE encourages minorities and other selected groups to participate in a research career.

William Bradley, NMSU sophomore, controls uranium concentrations for test liquids in a laboratory fume hood area. Bradley is from Window Rock, Arizona.

Rich Eriacho, of the Zuni Pueblo, places a sample loaded inside a quartz cuvette into a luminescent spectrometer. Eriacho is a junior.

EBID Historical Records Project

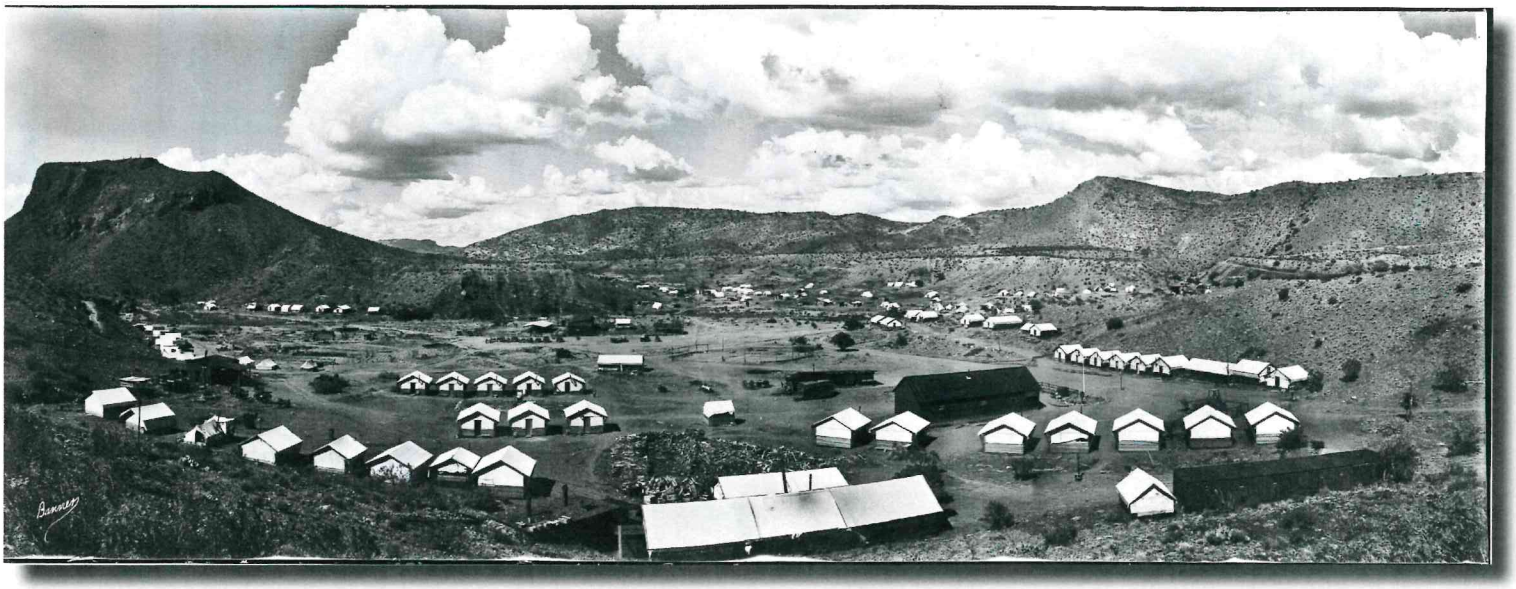
By Charles Stanford, Library Archives and Special Collections, NMSU

Historical records from the Elephant Butte Irrigation District housed in New Mexico State University Library's Archives and Special Collections Department will soon be more accessible to researchers than previously. Charles Stanford, the Processing Archivist in charge of this department's Rio Grande Historical Collections (RGHC), has been working with a team of students to arrange and describe these records for nearly two years. The first historical records were sent from EBID to the Rio Grande Historical Collections (RGHC) in 1984 where they were catalogued as Manuscript Collection number 235 (or Ms 0235). Many more records have been added over the years, and Stanford and his team are working to integrate all of these into a well-organized manuscript collection with improved access tools.

The Elephant Butte Irrigation District records currently in the RGHC span the years 1906-1969. They document the scheduling and delivery of irrigation water, the construction and maintenance of dams and ditches for irrigation and flood control, the management of finances related to the responsibilities of the district, and the district's interaction with government agencies and water users in other areas.

The RGHC holds many dramatic photographs of the Elephant Butte Dam and Reservoir, the irrigation and flood control systems served by the reservoir, and scenes of flood and drought through the years. Besides those from EBID, many others come from the Bureau of Reclamation, local individuals, and from hydrology reports by Herbert Yeo, who served as the State Engineer and in the Soil Conservation Service. These reports in fact came to the library through EBID, which acquired them some time in the 1950s. The images in Yeo's reports strike the eye even if the viewer knows nothing about the details of irrigation or hydrology. Items like photographs serve as a valuable tool for our mission to educate the public and invite interest in further learning, helping to steer public awareness to the necessity of managing water for life and civilization along the Rio Grande, and to inspire gratitude for the achievements of engineering that make our current economy possible.

Some of Yeo's photographs are available online but many are still not, and when they are finally made available over the Web, the Archives and Special Collections Department hopes that will increase a public appreciation of the history behind the building of the reservoir and the important work that EBID does, and generate more



Elephant Butte construction camp from Herbert W. Yeo papers, Ms 0094 (image #00942953).

Elephant Butte Dam spillway from Elephant Butte Irrigation District records, Ms 0001.

interest in this large and important manuscript collection.

EBID's day-to-day operations do not produce many dramatic photographs, but they do make agriculture possible in the region. The operations of the district have been closely tied with the changing face of agriculture in the Mesilla Valley, from cotton in the early years to the expansion of the pecan business during the last 30 years. The hundreds of historic images of agriculture in the Mesilla Valley held in the RGHC are evidence of the vital, behind-the-scenes work of the irrigation district.

The history of the district is intertwined with the lives of pioneer settlers of the Mesilla Valley, such as Thomas Casad, the subject of a biography in progress by New Mexico State Historian Rick Hendricks. The generations that have lived and farmed here since the late nineteenth century have all had their lives shaped by the workings of the irrigation district and its predecessors.

Repositories such as the RGHC were established with historians in mind, but besides history, there are other disciplines whose scholars may benefit from these records. Students of government can study the operation of quasi-public agencies such as the EBID, agricultural economics students and historians can study these records to determine the effects of irrigation in the Mesilla and Rincon valleys, hydrologists can study the flow of the Rio Grande from documents within the EBID records, and sociologists can examine the relationship between EBID and the community it serves.

In addition, the records of the district serve the needs of its constituency. Water right adjudication is a long and painstaking process that requires documentation of land ownership and water use because of New Mexico's prior appropriation water laws. These records serve to establish and maintain such rights.

"Processing" is what turns a set of records into an archival research collection. It includes several steps: cleaning, unfolding, and placing in long-term storage containers; then arranging and describing the records to help researchers locate relevant files more quickly and reliably. This includes not only the physical care and preservation, but also the arrangement and description: providing what we call finding aids to guide researchers through what can be vast amounts of paper, to help them find the records most relevant to their research questions.

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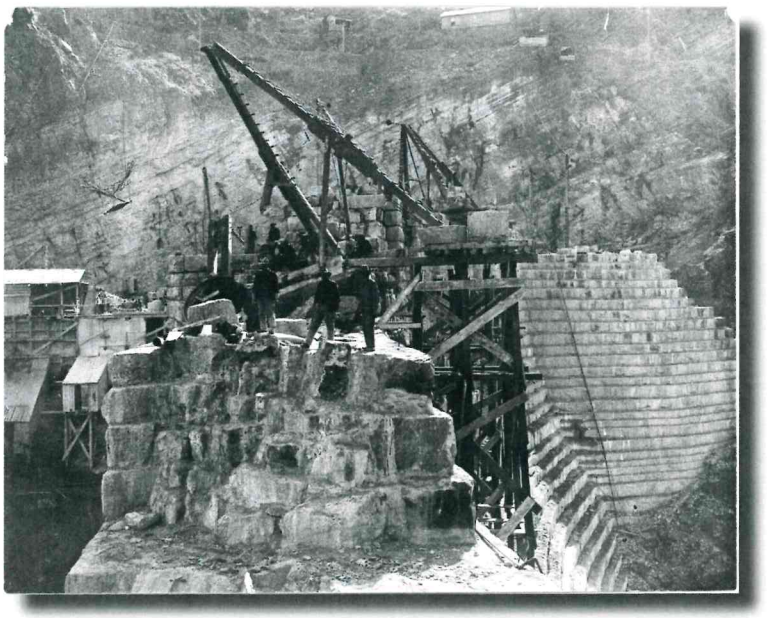
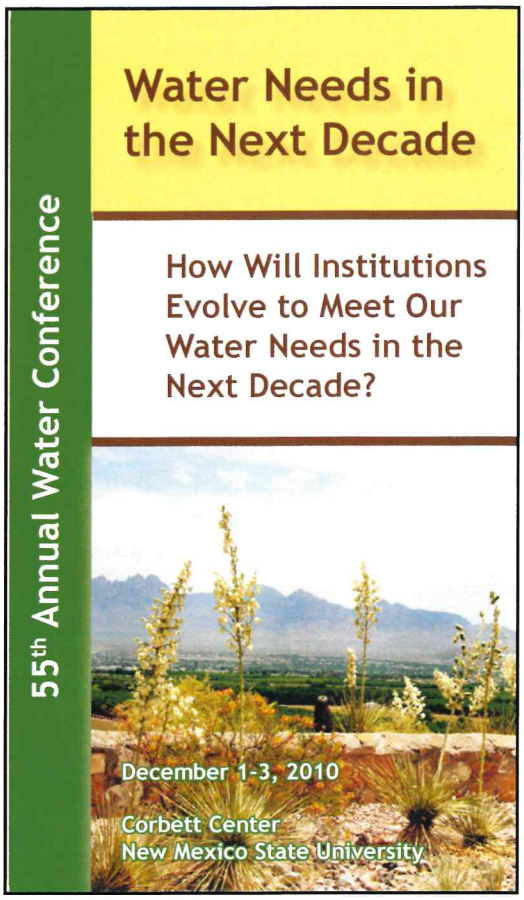


Construction of Elephant Butte Dam from Branigan Memorial Library photographs, Ms 0001 (image #00010229).



55th Annual New Mexico Water Conference

Wednesday, December 1, 2010

1:00 Tour of the Brackish Groundwater National Desalination Research Facility in Alamogordo hosted by WRRI Director Karl Wood and NMSU's Institute for Energy and the Environment Director Abbas Ghassemi

5:00 Reception at Fulton Center New Mexico State University

Thursday, December 2, 2010

8:30 Welcome
Karl Wood, WRRI Director
Barbara Couture, NMSU President

8:45 Tribute to Bobby J. Creel
Associate and Interim Director
WRRI 1986-2010

9:00 The Future of Water Adjudications in New Mexico
Judge Jerald Valentine, Third Judicial District Court
Greg Ridgley, OSE

9:50 Sandoval County Plans for Future Growth: Rio Puerco Desalination Plant
Guy Bralley, Sandoval County

10:15 Break

10:45 Challenges When Combining Mutual Domestic Organizations to Meet Community and Colonias Water Needs
Martin Lopez, Lower Rio Grande Public Water Works Authority

11:15 Interbasin Transfer Projects: Impacts on Communities and Ecosystems
Bruce Thompson, UNM

11:45 How Santa Fe Plans to Meet its Growing Water Demands
Claudia Borchert, Sangre de Cristo Water Division

12:15 Luncheon

The Future of Our Water Agencies:
Do We Have the Right Agencies Doing the Right Things?
Bill Hume, journalist and formerly with Governor Richardson's staff

Register online at http://wrri.nmsu.edu/conf/conf10/conf.html

Preliminary Program

1:30 Permanent Storage at Elephant Butte: Meeting the Needs of Recreationists
Neal Brown, Marina Del Sur, Rock Canyon Marina and Damsite Resort at Elephant Butte Lake

2:00 The Benefits of Restoring Our River Ecosystems
Beth Bardwell, Audubon Society

2:30 Sustaining Rivers through Instream Flows
Steve Harris, Far Flung Adventures and Rio Grande Restoration

3:00 Break

3:30 Environmental Flow Issues and Science
Tom Annear, Wyoming Game and Fish Department

4:00 Innovations in Rural Wastewater Management – Decentralized Approach
Richard Rose, New Mexico Environment Department

4:30 My Perspective on How Institutions Will Evolve to Meet Our Water Needs in the Future
Mike Hamman, Bureau of Reclamation, Albuquerque Office

Friday, December 3, 2010

8:30 Increasing Institutional Resilience for Water Conservation
Frank Ward, NMSU

9:00 Agriculture in New Mexico
Aron Balok, Pecos Valley Artesian Conservancy District

9:30 Rainwater Harvesting and Recharge Techniques for Flood Control and Improved Stormwater Quality
Vaikko Allen, CONTECH Construction Products Inc.

10:00 Break

10:20 Role of Artificial Recharge in Conjunctive Water Management
Daniel B. Stephens, DB Stephens and Associates, Inc.

10:50 How Do We Deal with Our Aging Structures?
Bruce Jordan, U.S. Army Corp of Engineers

11:10 Dealing with Aging Tribal Water Infrastructure
Derrick Lente, Middle Rio Grande Conservancy District, Pueblo of Sandia

11:30 Water Rights Settlement Agreements in New Mexico: Institutional Change Underway
Elizabeth Richards, Sandia National Laboratories

Tour Information

Brackish Groundwater National Desalination Research Facility, Alamogordo, New Mexico

Wednesday, December 1, 2010
1:00 – 5:00

Tour participants will meet at the Fulton Center parking lot on the NMSU campus at 1:00. The afternoon will begin on the NMSU campus where participants will have an opportunity to tour research plots on which brackish water is being applied to turf grasses. Buses will then transport participants to the facility in Alamogordo and will arrive back at the Fulton Center around 5:00. A reception at the Fulton Center will follow the tour.

The Brackish Groundwater National Desalination Research Facility is a focal point for developing technologies for the desalination of brackish and impaired groundwater found in the inland states. This facility brings together researchers from other federal government agencies, universities, the private sector, research organizations, and state and local agencies to work collaboratively and in partnership. The mission is to pursue research into supply-enhancing technologies for brackish groundwater including solutions to concentrate management, renewable energy/desalination hybrids, desalination technologies for produced water, and small-scale desalination systems.

Participants will view and learn about the skid-mounted water purifier that was used for a hospital in Biloxi, Mississippi following Hurricane Katrina and that was on standby for Haiti. Water desalination apparatuses being developed by entities such as NMSU, General Electric, the Bureau of Reclamation, and others will be highlighted.

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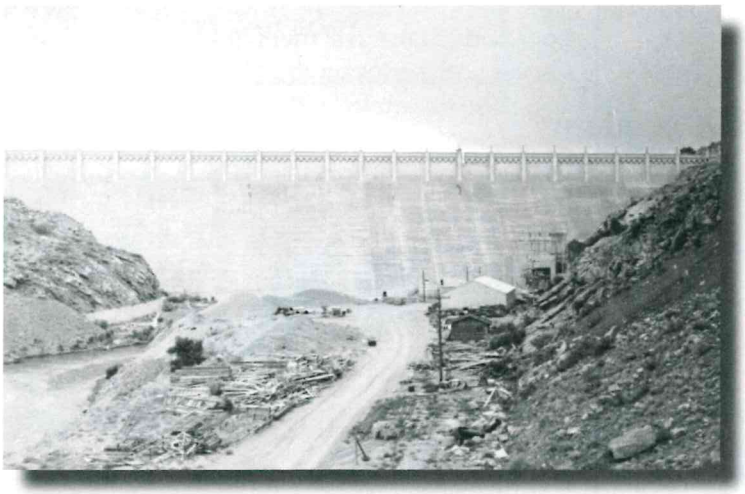
For every processed collection, there are several bodies of records or personal papers still sitting on the shelves of a repository, unorganized, and unknown. This is what we call our "processing backlog"– all the records we haven't arranged or described yet. Making our way through this is often slow, so we often look for outside funding to help with specific projects. These can involve processing records that are already in our custody, or more proactive enterprises where archivists actively collect records they judge important enough to preserve and make accessible for research.



Elephant Butte Dam from Elephant Butte Irrigation District records, Ms 0235.

Elephant Butte Reservoir, lower end from Herbert W. Yeo papers, Ms 0094 (image #00940284).

The EBID records were an example of this. In 1984, WRRI gave a grant to the Department of History to process EBID's historical records, which had been sitting in storage at the district offices and were in danger of physical deterioration.

The Principal Investigators in that grant were John W. Grassham and Darlis A. Miller, with Ira G. Clark as Consultant. Their project completed the first processing of the EBID records and produced a finding aid in 1985 as WRRI Report No. 190, which can be viewed in full text at http://wrri.nmsu.edu/publish/techrpt/tr190/tr190.pdf. This finding aid has been used ever since. It includes a detailed list of the contents by box and folder number as well as brief overviews of each division they assigned.

Since 1985, an equal volume of records has been added to the RGHC. In 2008 we began the work of processing these. With funding we received through the EBID board of directors, we hired two students who have carried out most of the hard work. They have prepared an inventory of the records added since 1985, and we are currently in the stage of assigning them to an organizational scheme.

Archivists usually organize research collections into series, usually based on divisions or departments in an organization, functions performed, activities of individuals, or types of records. The arrangement done in 1985 has 70 individual units of description, which will be amended to present a smaller number of series. The aim is to give a useful guide to researchers of varying degrees of experience and needs without being either vague or intimidating. The entire collection of EBID records, older and newer, will be reorganized in a way that reflects the district's operational structure, records management practices, and which serves the needs of researchers according to our current archival practices.

Assigning the records to these series is done using spreadsheets, without physically moving any of the boxes or folders: those stay in their spots on the shelves until we have their final order planned out. Once that order, the intellectual order, is fully established, it will be time to

begin physically putting folders and boxes into an order on the shelves that follows the intellectual order.

At that time we will also produce a new finding aid. The finding aid traditionally includes not only the list of series and contents, but also historical and scope and content notes: brief descriptions of the organization's history, and of the records themselves; the events and actions they record, the dates they cover, their significance and so on. This new finding aid will replace the old one on paper as well as online.

At that point the EBID records will be considered "fully processed" according to our current practices, but we will not be done with them yet. Although we will put the new traditional finding aid online in XML, we want to build a more interactive one that will offer access by multiple points. For example, a timeline outlining the major eras and landmark events in EBID's history could include links to file descriptions from certain dates. At a meeting with the archivists in charge of this project, Gary Esslinger, EBID manager, pointed out that many users of the records would benefit greatly from being able to access them chronologically. Since we are not arranging the entire collection in a simple chronological order, it will take a great deal of additional work to provide this kind of access, but it will be worth it.

Over the past two years, Cynthia Renteria (above), NMSU graduate student in history and Katelyn Attanasio, an NMSU recent graduate in English, helped process the EBID records into an archival research collection.

Secondly, we need to provide for the additional records that will come into the RGHC from EBID in the future. The district did not have a records management program at all until fairly recently, but now that this is in place, we can synchronize our arrangement of the records we have now with their records management practices. It is our intent to put together a system where future historical records can flow from EBID's office into our holdings without a ripple.

Note: The text of this article closely follows a video presentation prepared by the author for the Historical Society of New Mexico's 2010 annual meeting. Some of the photographs appearing here also appear in that video, which can be viewed online in two parts at:

http://www.youtube.com/user/CharlesBStanford#p/a/u/0/q3v0XGYr-jA

Tech Doctoral Student Studying Age Distribution of Water

by Thomas Guengerich, New Mexico Tech Public Information Office

Jesus Gomez hopes his hydrology research will help municipal leaders and scientists better understand how natural and human induced climate variability influence the flow and transport characteristics of groundwater systems.

A doctoral student at New Mexico Tech, Gomez has modeled the complex systems that dictate groundwater flow, specifically to determine the age distribution of water within a regional aquifer.

Under the tutelage of his advisor, Dr. John Wilson, Gomez has several projects – both modeling and field work – that attempt to dispel the assumption that groundwater age distributions are static over time.

For his research funded by the WRRI, Gomez simulated a typical large watershed that includes local, intermediate, and regional flow paths – paths that vary from hundreds of meters to thousands of kilometers.

Jesus Gomez collects temperature data along La Jara Creek in Valles Caldera National Preserve. A New Mexico Tech doctoral student, Gomez' research examines how climate changes affect the age distribution of water in Southwest aquifers.
Photo courtesy of Jesus Gomez

Using COMSOL Multiphysics software, Gomez created a hypothetical recharge system that mimics a typical arid Southwest situation. He then ran multiple multi-decade scenarios that included differing climate and weather.

"We studied the factors that influence flow change over time," he said. "We're looking at the classic problem in groundwater hydrology: how long has the water that we sample been in the aquifer and where does it come from?"

He bases his work on the theory that in any one aquifer, water of varying ages will commingle – from years old to thousands or millennia old. Over time, an aquifer will recharge at differing rates, largely dependent on variations in climate.

"Essentially, when you take a dip of water, you don't have one age, but a distribution of ages," he said. "Maybe 80 percent is 10 years old and 10 percent could be 100 years old and the rest is much older – as one example. What we have observed is that changes in climatic conditions have a strong effect on the age distributions we observe."

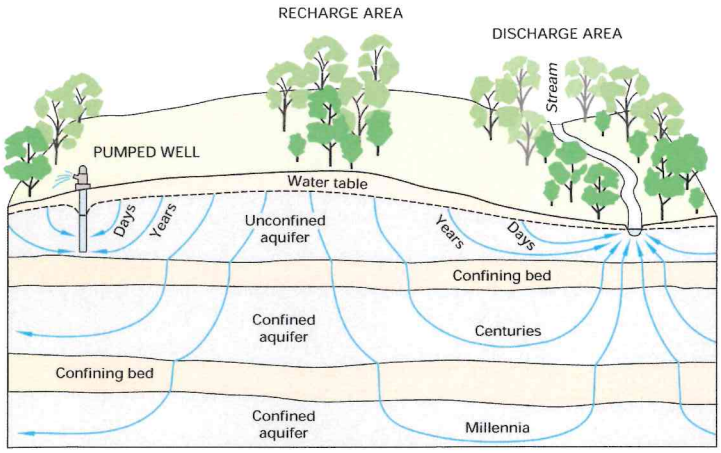
His modeling work has shown fluctuations in seasonal climate changes and in decadal stages.

Gomez employs environmental tracers – either natural or introduced tracers – to study flow path and regeneration.

"We want to improve our interpretation of environmental tracers and understand better and do an assessment of risks in an aquifer," he said. "We want to understand where water comes from. A lot of decisions about when you take water and how much you pump are based on how long the water is in the system."

By examining the age of water in an aquifer – and the distribution of various ages – Gomez' research will help water managers make more informed decisions. His work will help advance the understanding of not just how water flows, but also how contaminants move.

With his WRRI research coming to a close, Gomez and Wilson have embarked on a new field study to examine



This graphic shows how water of varying ages mixes within an aquifer. USGS graphic

a much smaller system – a river meander in the Valles Caldera. Funded by the NSF, they are now putting their theoretical work funded by the WRRI to the test. Gomez and his colleagues will use a variety of dating techniques to test water samples. They will examine standard tracers – carbon-14, helium, tritium and stable isotopes of water – to develop a snapshot of the age distribution.

"If you're looking at a meander or a regional system or the ocean, it's the same problem," he said. "How long do things stay in the system. The problem is always the same – the things that drive flow change over time."

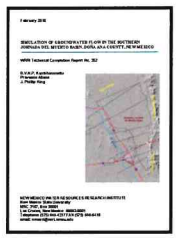
Gomez earned his master's degree at New Mexico Tech in 2008 and will complete his doctoral studies in 2011 or 2012. A native of Columbia, he earned his bachelor's in civil engineering with emphasis on channel hydraulics at the National University of Columbia in Medellin.

He developed an interest in groundwater hydrology because Columbia is mainly dependent on surface water.

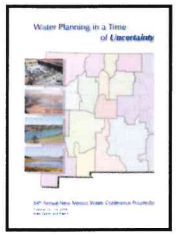
"It seemed strange to me that we [in Columbia] don't use groundwater," he said. "The issue is that we don't have the expertise to exploit the resource. This course of study is good for me if I want to return and contribute. ... If we have people with knowledge of groundwater hydrology, we can do a better job of using our resources correctly."

WRRI Recent Publications

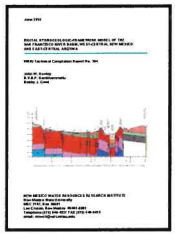
The WRRI has published two technical reports (and a soon to be published conference proceedings) since the last issue of the Divining Rod. These reports are peer-reviewed completion reports resulting from WRRI funded projects. All reports are available online at: **http://wrri.nmsu.edu/publish/publications.html**.



Simulation of Groundwater Flow in the Southern Jornada del Muerto Basin, Doña Ana County, New Mexico
February 2010 – Report No. 352 by B.V.N.P. Kambhammettu, Praveena Allena, and J. Phillip King



54th Annual New Mexico Water Conference Proceedings, Water Planning in a Time of Uncertainty
July 2010 – Report No. 353, edited by Catherine T. Ortega Klett



Digital Hydrogeologic-Framework Model of the San Francisco River Basin, West-Central New Mexico and East-Central Arizona
June 2010 - Report No. 354 by John W. Hawley, B.V.N.P. Kambhammettu, and Bobby J. Creel

2010 New Mexico Water Research Symposium

August 3, 2010, Macey Center, NMTech

40 presentations; 30 posters

http://wrri.nmsu.edu/conf/tc10/symposium.html

Kudos

Congratulations to former UNM student Amy Williams for receiving the 2009 American Geophysical Union, Hydrology Section Outstanding Student Paper Award and the 2009 New Mexico Geological Society Best Student Poster Award. Amy received a WRRI student research grant for her project relating to the surface water chemistry of the Sevilleta Basin. Her research was highlighted in the November 2009 issue of the *Divining Rod*. Amy graduated with a master's degree from UNM last year and is now a doctoral student at the University of California at Davis.

Gregory Torell, an NMSU graduate student working on a WRRI-administered award from the U.S. Geological Survey entitled *Monitoring and Forecasting Climate,Water and Land Use for Food Production in Afghanistan* received the NMSU College of Agricultural, Consumer, and Environmental Sciences Deans Award for Research Excellence, 2010. Gregory wrote his master's thesis on the *Economic Analysis for Improved Water Management, Food Security, and Rural Livelihoods in Afghanistan's Balkh Basin.*

Matthew F. Kirk, recipient of a WRRI student research grant in 2007, is now a postdoctoral appointee in the geochemistry department at Sandia National Laboratories. Matthew recently indicated that the WRRI grant gave him the freedom to pursue his own research questions while working on a Ph.D. at UNM. He along with his coauthors have now published their results in Geochimica et Cosmochimica Acta 74 (2010) 2538-2555 in a paper entitled, *Experimental Analysis of arsenic precipitation during microbial sulfate and iron reduction in model aquifer sediment reactors (*by Matthew F. Kirk, Eric E. Roden, Laura J. Crossey, Adrian J. Brearley, and Michael N. Spilde). Matthew's WRRI student grant research was described in the January 2008 *Divining Rod* newsletter.

Bobby J. Creel, Associate and Interim Director at the New Mexico WRRI from 1986-2010, and who died earlier this year, was awarded posthumously the Red Chile Award from the New Mexico Geographic Information Council (NMGIC). The award was made at the organization's May meeting with Dr. Creel's daughter, Betsy Creel Goodman accepting the award on her father's behalf. John Hawley, longtime associate of Dr. Creel, paid tribute to his friend and colleague at the award ceremony. The NMGIC's Red Chile and Green Chile Awards for Outstanding Service are given to individuals who have greatly contributed to the New Mexico geospatial community. According to NMGIC, "While New Mexico is fortunate to have a wealth of 'GIS talent,' the awards for outstanding service are meant to convey our gratitude for going above and beyond in helping others and in community spirit." The award is a plaque that acknowledges Bobby's outstanding service to the geospatial community. Bobby served on the NMGIC Board of Directors for several terms and continued to be of service to NMGIC by developing a database and online ballot for the annual NMGIC Board of Directors election. He also was instrumental in encouraging student participation in NMGIC, especially from NMSU.

David Jordan (left) presented the NMGIC Red Chile Award to Betsy Creel Goodman, accepting on behalf of her father, Dr. Bobby J. Creel. Dr. John W. Hawley (right) paid tribute to Dr. Creel at the organization's May meeting.