



Water Resources Research Center

Research, Extension & Education for Real World Issues

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Rillito River, Tucson - Courtesy of Watershed Management Group



Annual WRRC Conference



Arizona Project WET - Student Water Audit



Central Arizona Project Canal

2011 Annual Report



THE UNIVERSITY
OF ARIZONA.

College of Agriculture
and Life Sciences



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College of Agriculture
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Independent Voice For Arizona's Water Future

A unit of UA's College of Agriculture and Life Sciences, the Water Resources Research Center (WRRC) promotes understanding of critical regional water management issues through research, community outreach and public education.

Established under the 1964 Federal Water Resources Research Act, the WRRC has a wide array of research, education and information transfer programs. Water news and information are provided to the academic community, water professions, government officials, students and the public. The WRRC is one of five UA water centers responsible for implementing the Water Sustainability Program, a component of the Water, Environmental and Energy Solutions Initiative with funding from the UA's Technology and Research Initiative Fund.



Groundbreaking Water Research and Environmental Projects

The WRRC manages a grant program under the Water Resources Research Act, Section 104(b), which supports research at the three state universities of Arizona, and administers grants funded under section 104(g). The WRRC also manages the Arizona section of the United States-Mexico Transboundary Aquifer Assessment Program, authorized by Congress in 2006. The WRRC in-house research program focuses on questions with policy relevance in Arizona and the southwest region, supported by grant funding and UA's Technology and Research Initiative Fund. See *Appendix Table I* for a summary of projects and funding awards.

WRRC Director



Sharon Megdal, Ph.D., WRRC Director, is the C.W. and Modene Neely Endowed Professor for Excellence in Agriculture and Life Sciences. In addition, Dr. Megdal directs the WSP within the WEES Initiative and is a Professor/Specialist in the UA Department of Agricultural and Resource Economics and the Department of Soil, Water and Environmental Science. Dr. Megdal holds courtesy appointments with the UA School of Government and Public Policy; School of Geography and Development; the Planning Degree Program; College of Architecture and Landscape Architecture and The College of Public Health. Recently, she became affiliated faculty at the James E. Rogers School of Law and the Arizona Center for Judaic Studies. She is a member of the Arid Lands Resource Sciences Graduate Interdisciplinary Program and the Institute of the Environment. Dr. Megdal was elected in November 2008 to the Central Arizona Water Conservation District Board of Directors, which oversees the Central Arizona Project. She has been a member of the National Institutes for Water Resources since 2004, the UNESCO-GEF (Global Environmental Facility) Transboundary Waters Assessment Programme, Groundwater Expert Group, since 2009, and began a term on the Advisory Board to the UA Center for Middle Eastern Studies in 2011.

Dr. Megdal's work on water policy and management covers a broad spectrum of projects; major themes include water assessment, governance and planning, and competition under scarcity. During the reporting period, Dr. Megdal gave numerous presentations on water management and planning from multiple perspectives. She published articles, reports and commentary based on her research (see appendix), and led a study on water conservation for environmental enhancement that has resulted in the Conserve to Enhance (C2E) program now being demonstrated by Tucson Water. The C2E program has expanded and is generating interest in several western states. As part of a larger research program on securing water for the environment, Dr. Megdal also led a study of environmental water needs in Arizona and co-authored a paper on Arizona water law. She was a leader of the Regional Water Assessment Task Force (RWATF), which held four ThinkTank sessions in the Tucson Active Management Area in 2010. The results were presented in an August 2011 report. On sabbatical this spring, Dr. Megdal writes a regular column for Arizona Water Resource.

Dr. Megdal encourages international collaboration. Her spring semester sabbatical at The Hebrew University will focus on groundwater policy. The visit is being hosted by the geography faculty of the Mt. Scopus campus in Jerusalem and the resource economics faculty at the agricultural campus in Rehovot. In November 2011, Dr. Megdal gave an invited presentation at a biennial water conference in Tel Aviv that was covered by the Jerusalem Post, and also made a presentation at a workshop convened by the Jordanian Royal Scientific Society. While in the Middle East, she prepared a presentation of a comparative analysis of Arizona and Israeli water policy for an on-campus presentation made in October 2011. With colleagues, she has been exploring the possibility of a tour to the Middle East for Arizona water professionals.

Dr. Megdal has been instrumental in initiating the new Water, Society and Policy Master's program based in the School of Natural Resources and the Environment. This program has enrolled its first three students, though enrollment is constrained by available advisors and funding. Dr. Megdal also advises graduate students.

Research Programs and Projects

Federal Water Resources Research Act Section 104 Program

Despite funding uncertainties that lasted through the spring, the WRRC selected three proposals for 2011 funding in the 104b grants program (Table II). These projects are now underway, with completion expected a year after funding was received. In addition, final research reports on the five 104b projects funded in 2010 (Table III) have been submitted to the U.S. Geological Survey. Reports are posted on the WRRC website.

A 104(g) nationally competitive research grant of just over \$120,000 was awarded in 2010 to Dr. Ty Ferre of the UA Department of Hydrology and Water Resources for the project, *Improving Hydrologic Investigations through Multi-Model Analysis and Discriminatory Data Collection*.

U.S.-Mexico Transboundary Aquifer Assessment Program (TAAP)

Despite a lack of appropriations since 2010, this federally authorized program has remained active due to carry-over funding. A report to Congress will cover the program's first five years in the Arizona-Sonora Santa Cruz and San Pedro aquifers, as well as the work performed by Texas A&M and New Mexico State Universities (NMSU). The Arizona-Sonora transboundary aquifers have been accepted as case studies for UNESCO's Internationally Shared Aquifer Resources Management Programme. Dr. Chris Scott and Dr. Megdal recently published a paper on the Arizona-Sonora experience in the international journal *Water*. TAAP work has been well received within the USGS groundwater division, where it is housed.

Mexico recently determined that it can fully fund a project half of which the U.S. had originally funded. Consequently, this funding is being released from commitment and can now be used to fund programmatic activities between January 2012 and early 2013. In December of 2011, preliminary discussion was held within the cooperative framework from the International Boundary and Water Commission about a binational and

bilingual report focusing on the Santa Cruz and San Pedro aquifers. The planned report demonstrates a truly collaborative approach to the Arizona-Sonora portion of the TAAP.

Collaborators at Texas A&M and NMSU continue to communicate with the Department of Interior and congressional offices regarding future funding. The TAAP program was approved in late 2006 for a ten-year period with a \$50 million maximum authorization; to date only \$2 million has been appropriated.

Water Harvesting Program

WRRC is building on its previous efforts to support water harvesting demonstration sites and knowledge transfer in new initiatives in 2011. The WRRC initiated a local Rainwater and Stormwater Professionals Network (RSPN) and hosted two roundtables to bring fragmented resources and expertise together. The group will meet semi-annually to share information on research and other activities. Jackie Moxley was also granted a University of Arizona Green Fund Award in spring 2011 for a water harvesting demonstration project, making the WRRC a demonstration site. Signage, low water use plants, eaves troughs and cisterns were installed to demonstrate positive impacts of urban rainwater harvesting.

The WRRC received over \$80,000 for *Utility Guide to Rainwater/Stormwater Harvesting as an Adaptive Response to Climate Change* from the U.S. Bureau of Reclamation, Desert Landscape Conservation Cooperative, WaterSMART program. The two-year project, initiated in November 2011, will develop a decision support tool for public utilities and agencies to evaluate suitability and cost-effectiveness of rainwater and stormwater capture at various scales. An 11-member Technical Advisory Committee was established from the RSPN membership to provide expert guidance. The project will investigate water harvesting benefits, including additional supply, reductions to flooding, and conservation. An article on the project was published in December's ARCSA Quarterly Newsletter.

Other Research

Regional Water Assessment Task Force (RWATF): The RWATF, composed of Dr. Megdal and government officials, community volunteers, and business professionals, worked for 18 months on assessing the Tucson region's interest in collaborative, long-term regional water planning. This volunteer effort addressed the community's request to build upon a recently completed city-county effort. The RWATF used the ThinkTank process together with input from stakeholders and prepared a report that summarized hundreds of stakeholder responses and offered recommendations for moving forward. The RWATF held a well-attended public meeting for feedback in late September 2011 and a focus group discussion on December 12. No funding has yet been identified for next steps.

Water for the Environment: In 2011, Dr. Megdal and Ms. Joanna Nadeau, with assistance from a law student, published "The Forgotten Sector: Arizona Water Law and the Environment" in the Arizona Journal of Environmental Law & Policy. The paper

examines how the environment is recognized in Arizona water law as a water using sector. The paper also highlights opportunities for acknowledging the environment's needs in the current legal context, specifically including voluntary programs like Conserve to Enhance.

Sensitivity of Residential Water Demand to Recent Price Increases in Urban Phoenix Communities, a project with G.S. Thompson and S. Aradhyula, is a pilot project to study the effects of rate increases and other water conservation measures on residential demand for water.

Agricultural Water Security: Interstate collaboration with a sister Water Resources Research Institute in Colorado led to a project that focuses on planning for water research extension and education as a means for addressing agricultural water security in the Colorado River Basin

Blue Ribbon Panel Research Recommendations: The government agencies responsible for implementing the November 2010 recommendations of the Blue Ribbon Panel on Water Sustainability agreed that those recommendations related to research are best carried out by the universities. WRRC personnel, along with colleague Dr. Channah Rock, met with agencies in October 2011. The 2012 104b call for proposals was tailored to the research recommendations of the Panel. The WRRC is using some TRIF funds to support student research on topics related to reuse and the water-energy nexus.

Arizona, Israeli, Palestinian Research Collaborations: Internationally, Dr. Megdal and Dr. Robert Varady, Deputy Director of the UA Udall Center for Studies in Public Policy, are working together on activities to further collaborative research on water management in Arizona, Israel and the Palestinian Territories. Funds from NSF supported an international workshop, which led to a volume of collected papers, as well as opportunities for building relationships through participation in conferences and meetings. The final grant report was submitted in 2011.

Environmental Projects

A combination of research and outreach projects, WRRC's environmental projects focus on the needs of the environment for a sustainable supply of water in the face of consistent and growing human water demands. Research supports efforts to establish a foundation of understanding from which to discuss water in the environment in terms of requirements for sustainability of Arizona's rivers and riparian areas as well as the state's legal context. Outreach efforts seek to establish the environment as a valid participant at the water supply planning and bargaining table, and to provide mechanisms for connecting water conservation to environmental enhancement.

Planning for Environmental Water Needs

In July 2011, the WRRC received its second funding award from the Nina Mason Pulliam Charitable Trust for a three-year project. The award will allow the WRRC to apply information from recent assessments of desert rivers and riparian areas to assist Arizona's decision makers with water planning. This new initiative adds to the momentum at the WRRC in efforts to increase awareness of environmental water needs through innovative strategies for water planning and conservation. This project is also supported by funding from the U.S. Bureau of Reclamation.

Examples of WRRC products from previous Pulliam funding include:

- **Arizona Environmental Water Needs Assessment:** In March 2011, the WRRC published two technical documents from a year-long project to assess the state of knowledge about Arizona's environmental water needs. The Arizona Environmental Water Needs Assessment (AzEWNA) Report and the Arizona Environmental Water Needs Assessment Methodology Guidebook explore and synthesize efforts to quantify the water needs of river systems in Arizona.
- **Applying the Information:** The WRRC participated in the 2010-2011 Water Resources Development Commission (WRDC) to assist the Commission in applying information about Arizona's environmental water needs from the AzEWNA. The WRDC's Environmental Working Group drew on AzEWNA project information about the amount of flooding needed to support various habitats around the state as well as findings about economic values of environmental water uses.

C2E Project: Saving Water for Nature

The Conserve to Enhance (C2E) Project aims to connect conservation actions with securing water for the natural environment. WRRC activities towards the C2E goals in 2011 focused on three areas: advancing the Tucson pilot of the program, program development via outreach activities, and expanding C2E into other areas.



Joanna Nadeau is a Research Analyst working to quantify and address environmental water needs. Over the past year, she worked to implement and evaluate pilot programs of C2E. Outreach components of this work involved presentations to regional audiences and meetings with stakeholders. Ms. Nadeau established relationships with non-profits and municipal water professionals in several western communities to lay the foundation for C2E pilot programs in Tucson, Arizona; Las Cruces, New Mexico; and communities in Colorado. She and her team secured the city's cooperation on the pilot now underway in Tucson. Ms. Nadeau wrote and distributed a progress report to interested communities. She also co-authored two related papers with Dr. Megdal in *The Kachina News* (Vol. 27, No.3) and in the *Journal of Environmental Law and Policy*. Her work with Dr. Megdal on a one-year assessment of Arizona's environmental water needs, funded by the Nina Mason Pulliam Charitable Trust, led to a three-year follow-on grant to raise awareness among policy makers and planners about environmental water needs. Ms. Nadeau coordinates the activities of the environmental projects from Ithaca, New York since moving there last summer with her husband, a graduate student at Cornell University. She coordinates the activities of the Environmental Program from Ithaca.



Aaron Lien joined the WRRC in August 2011 as a Research Analyst on the environmental research program. He has been working on expanding the C2E concept to other states, including Colorado and southern California. Mr. Lien prepared a series of presentations to the Metropolitan Water District Water Use Efficiency Meeting, the WaterSmart Innovations Conference in Las Vegas, NV, and the American Water Resources Association in Albuquerque, NM.



Candice Rupprecht recently transitioned from managing the Arizona Master Watershed Steward program to a position as Program Coordinator of Applied Programs. Since that time, she has managed the Arizona Project WET Water Investigations Program. In addition, she works with Dr. Megdal and Ms. Nadeau on C2E. Both programs emphasize connecting urban water users with their natural environments and riparian areas. She is a board member for the Arizona Association for Environmental Education.

Advancing Tucson C2E Pilot: Over the past two years, the WRRC has worked in partnership with the Sonoran Institute and Watershed Management Group (WVG), and with the support of Tucson Water to develop the Tucson pilot program. The Tucson C2E pilot grew significantly in 2011. A formal review of pilot development process is being published in the *Journal of the American Water Works Association* in February 2012. Tucson's Atturbury Wash, managed by Tucson Audubon Society, was selected to receive pilot donations. The Tucson pilot enrolled 60 applicants, 45 of whom received subsidized rainwater harvesting installations. The pilot had saved 805,000 gallons of water through the third quarter of 2011.

Development of C2E Programs through Outreach Activities: In 2011, the C2E reached almost 1,000 stakeholders at conferences and meetings to share the C2E concept, outcomes from the Tucson pilot program, and opportunities for addressing environmental water needs. Articles and reports based on the work were disseminated to interested stakeholders; more information is available on the C2E website.

Expanding the Reach: Over the last year, the C2E team has also engaged in outreach activities to expand the reach of the program into new communities. The team has reached key stakeholders in California, Colorado, New Mexico, and Utah. In July 2011, WRRC secured a grant of over \$130,000 from Walton Family Foundation to support C2E outreach throughout the Colorado River Basin. The grant enabled the WRRC to hire Aaron Lien to conduct outreach and implement new programs in interested areas. The team is currently working with local stakeholders to establish C2E programs in two Colorado communities and is working toward involvement in other states as well.

C2E Plans for 2012

2012 C2E plans include developing a brand with a logo and trademark in addition to creating tools for monitoring, evaluation, and training. A water conservation calculator will be developed, and a webinar series will be implemented. It should be noted that the Tucson C2E Pilot received substantial media coverage during our recruiting phase for local participants.

- UA News; January 18, 2011; "*UA behind community water conservation project*"
- Waterblogged blog by Shaun McKinnon (Arizona Republic reporter); January 19, 2011; "*Save water, save the environment*"
- Arizona Public Media radio interview of Joanna Nadeau; January 20, 2011
- Western Farm Press; January 20, 2011; "*Water conservation project backed by University of Arizona*" (re-post of UA News article)
- Brown and Caldwell Water News, Arizona Edition; January 21, 2011 (re-post of UA News article)
- Environmental Fund for Arizona *Green Sheet*; February 2011 (re-post from Waterblogged post)
- Arizona Daily Star; February 21, 2011; "*UA effort links saving water, eco-restoration*"



Water Sustainability Program (WSP) at the WRRC

The Technology and Research Initiative (TRIF) has enabled water leaders at UA to make strategic investment in research, education and outreach programs that has resulted in significant contributions to Arizona water resource issues. The Water Sustainability Program (WSP) is one of the designated areas for funding. The WRRC is one of five UA water centers that has served as the management core for the WSP and continues to play a pivotal role in implementing, developing, and managing program components, under the leadership of WRRC director, Sharon Megdal.

With WSP funding, WRRC continues to expand its applied research programs in water policy and management and to provide high quality education and outreach products and publications mentioned in other sections. Training opportunities for graduate students have been a major benefit of this funding. See Section IV in the appendix for a list of TRIF program funding related to WRRC and WSP campus-wide.



Water, Environmental and Energy Solutions (WEES) Initiative

As of July 1, 2011, in a reorganization of TRIF initiatives intended to foster interdisciplinary, innovative research and technology across water, the environment and energy nexus, WSP became a partner in

The University of Arizona

the Water, Environmental and Energy Solutions (WEES) initiative with the Institute of the Environment (IE) and the Renewable Energy Network. These three entities together manage WEES funding under co-directors Diana Liverman (Director of IE) and Sharon Megdal. A key metric for the TRIF programs is return on investment, so the focus is on stimulating external funding through seed grants, cost-sharing, collaborative projects, new hires and other funding mechanisms (Table V). Training the next generation of environmental leaders is another objective achieved through funding opportunities for students that include fellowships, internships and travel grants.



Jackie Moxley, Program Director for WEES and WSP, is responsible for overall management and coordination of programs and reporting. She worked closely with the WEES executive team this past year to develop and deliver new interdisciplinary grant programs to enhance water, environmental and energy research at UA. In addition to these activities, she was granted a Green Fund Award to implement a water harvesting demonstration project at the WRRC. Fact sheets for the water harvesting project are in development. With Susanna Eden, Ms. Moxley initiated the network of Rainwater Stormwater Professionals and wrote a successful proposal for a 2011 WaterSMART grant to develop water harvesting assessment tools for decisionmakers. Among other activities she reviewed Cooperative Extension publications on water harvesting. As of this year she serves on the President’s Advisory Council for Environmental Sustainability as an elected member of Eco-Ops, a UA employee group representing Appointed Professionals.

The screenshot shows the WEES website with the University of Arizona logo and navigation tabs for 'WHO WE ARE', 'FUNDING OPPORTUNITIES', 'AWARDS', and 'SECURE LOGIN'. The main content area includes an 'About Us' section, a 'DUE FEB 24TH' announcement for Equipment Grants and Capacity Building Workshop Grants, and an 'ANNOUNCEMENTS' section with three bullet points regarding proposal deadlines and funding requirements.



Educational Innovation

Arizona Project WET

Arizona Project WET (APW) is a water education program with a long history of successful teacher professional development and student engagement. Having developed relationships with school districts and communities throughout Arizona, the program relies largely on the interest and support of both public and private donor organizations. Garnering well-earned attention, APW programs have been featured recently in the Nature Conservancy's Field Notes, Know99 Television, Phoenix on Arizona Family (Channel 3) and other media.



Kerry Schwartz, Director of Project WET, runs a statewide water education program that expands each year and now reaches tens of thousands of individuals. As an Associate Specialist with the Department of Agricultural Education, she combines her knowledge of water resource management and hydrogeology with an ability to engage adults and students in learning. Ms. Schwartz administers grants from county and city entities, as well as public and private companies and nongovernmental organizations. In 2010, her programs received NASA funding through a project with the Arizona-Sonora Desert Museum. She has developed partnerships and sponsorships with the Abbott Fund and The Nature Conservancy that focus on programming in Pinal and the Phoenix Valley, respectively. She was also presented the Individual Program Leadership Gold Award in recognition of exemplary leadership by the national Association of Natural

Resource Extension Professionals. Ms. Schwartz has recently served, or is about to serve, in outreach capacities in national and international programs. Some of Ms. Schwartz's roles in outreach programs include:

- National Advisor (2011) and Education Specialist (2010), Environmental Resources Center, University of Wisconsin USDA Planning Grant, Mapping the Future: Youth-Water Programming for the 21st Century and Water Equals Proposal
- Member, Science and Technology Action Committee for Arizona Centennial Science Festival Week, planned for Feb. 2012
- Participant, Theodore Roosevelt Dam Centennial, Salt River Project PERA Club, Phoenix, Arizona, Mar. 18, 2011
- Participant, Science Foundation Arizona, National STEM Forum, Wyndham Phoenix Hotel, Feb.14, 2011



Holly Thomas-Hilburn, Direct Student Outreach Program Coordinator, manages programs that are delivered to students directly by APW trained facilitators, including the Sweetwater Wetlands Water Festival program and the Laurel Clark Earth Camp Program. Ms Thomas-Hilburn works directly with the APW Director to develop assessment tools to measure the impacts of all APW programs. Her expertise in environmental learning has been used to improve existing programs and build a solid foundation for new programming.



Rachael Sandler started with Project WET as an Americorps member and went on to coordinate the Tucson Water program in which she served. She is now in her second year as Coordinator for the Tucson Education Program. She assists in hiring, training, and supervising AmeriCorps members. She schedules and coordinates AmeriCorps members' work in classrooms around Tucson and at Sweetwater Wetlands Water Festivals twice a week. She helps to communicate with the Wildcat Corps office and assists AmeriCorps members in fulfilling their requirements. She also coordinates APW participation in community outreach events.



Since joining the WRRC in October 2011, **Ryn Shane-Armstrong**, Instructional Specialist for the Arizona Water Festivals, has coordinated a program that organizes water education events for fourth graders. This includes supplying local communities with technical support, equipment and trainings for teachers and volunteers, and local Water Festival Coordinators and committees. Mr Shane-Armstrong works with local coordinators across the state to deliver the water festival program.

Teacher Professional Development

Arizona Project WET uses four nationally recognized, interdisciplinary curriculum guides to deliver water education programs relevant to Arizona's unique story, meeting Academic and Common Core Standards. The interdisciplinary lessons can be used in all subject areas. Professional development workshops incorporate focus and inquiry questions, lesson assessments, and the use of science notebooks. APW is guided by an advisory council comprised of water and education specialists that meets quarterly.

In 2011, APW facilitators conducted workshops for hundreds of teachers who collectively teach a total of almost 30,000 students each year. Workshop evaluations show an overwhelmingly positive response to the activities.

Water Investigation Program

The APW Water Investigation Program (WIP) is a new student outreach and teacher professional development program for middle schools, launched with the 2010-2011 school year. The goal of the WIP is to develop students' critical thinking and problem solving skills through relevant subject matter. The WIP integrates applied science, technology, engineering and math (STEM) subjects. Teachers agree to teach 12 class periods for each of WIP's three thematic units over a school year.

The first thematic unit, *Water Use Inquiry*, engages students in water audits of their schools and homes. Students learn scientific practice and fundamental inquiry skills, achieving over 20,000 gallons of water savings per community. The second unit, the *Water Resources and Supply Inquiry*, explores connections between urban water use and Arizona's water resources. This includes a close look at the role of the Salt River Project and the Central Arizona Project (CAP) in delivering and sustaining water supplies for ecosystems and communities. Students develop knowledge of water resources from the individual household scale to annual river flows and city water budgets. The WIP concludes with the *Riparian Inquiry*, a field

study at a Nature Conservancy Preserve during which students conduct their own investigations. Finally they synthesize their learning by presenting at a WIP Symposium.

Pilot Water Investigations Program & Symposium

The pilot WIP engaged teachers and middle school students from Florence, St. David, Chandler, and Tucson. Teachers attended workshops and studied school and home water use, the inquiry process, and Arizona's riparian areas. Students conducted a water audit and their own investigations at the San Pedro River Preserve, Three Links Farm (also on the San Pedro) and Gilbert Riparian Preserve. Students later shared their findings at a Water Investigations Program symposium at the UA. Students were mentored by twenty UA graduate student "mentor scientists." Mentor scientists are listed in Appendix Table VI.



Water Investigations Program through The Nature Conservancy Partnership

APW launched a full-scale Water Investigations Program with support from The Nature Conservancy (TNC) to expand to the Phoenix Valley in early 2011. An Applied Program Coordinator was hired to oversee the Water Investigations Program along with two Community Coordinators, who directly support teacher implementation of the WIP. WIP Thematic Units 1 and 2 were presented in July 2011 and October 2011, respectively.

Between March and May of 2011, the program gave Water Scene Investigators Presentations in Phoenix Valley schools to promote the WIP Teacher Cohort and delivered presentations to middle school classes, reaching over 1,700 students and conserving a projected 3.4 million gallons of water per year. In July 2011, the program launched the WIP Teacher Cohort with middle school teachers from the Phoenix Valley. These teachers are implementing APW lessons, including water audits, with almost 2,000 students. Estimated water savings from these water audits is 6.5 million gallons per year.

NASA Earth Camp Program

Arizona Project WET, in partnership with the Arizona-Sonora Desert Museum and the Planetary Sciences Institute, received a grant from NASA for the Laurel Clark Earth Camp Experience. Earth Camp for youth opens eyes and minds to our interdependent planet. It draws connections from our homes to our region, to the globe, and to perspectives on Earth from space. Earth campers work in teams to study ecosystems and how to better live in harmony with the natural world. This year, 20 middle school students and 20 high school students participated in the program. Middle school students focused on water and human impact on the planet in the Tucson area. High school students participated in a 12 day field camp, including a 5 day trip down the Green River through Utah's Desolation Canyon. Campers used journals and digital cameras to record observations.

The teacher Earth Camp models lessons on how to teach about water from the molecular to the regional level. The experience included a canoe trip on the Colorado River near the Hoover Dam, where 16 teachers were immersed in water science and learning about water management. The program connected the ground-based perspective to views from space, with subsequent workshops on how to use NASA satellite images to increase conceptual understanding.

Tucson Water Program – Sweetwater Wetlands and Groundwater Flow Model

In Tucson, APW has integrated Project WET lessons into the curriculum for a third of the science taught in 3rd and 6th grades. A groundwater flow model presentation and a field day at Sweetwater Wetlands are part of the third grade curriculum, delivered by APW's Americorps members through the Wildcat Corps. In 2011, APW gave in-class groundwater flow model presentations to almost 4,000 students and water festivals at Sweetwater Wetlands to 3,700 students. For the sixth grade program, the groundwater flow model presentation was delivered to 2,580 students by the Wildcat Corps. The Sweetwater Wetlands Water Festival was featured in a Fox News Story in November.

Arizona Water Festival Program

Water Festivals are engaging, standards-based events for fourth graders where students learn about watersheds, groundwater, the hydrologic cycle and water conservation. The program is in its tenth year. In 2011, ten water festivals throughout the state reached thousands of students from February to November.

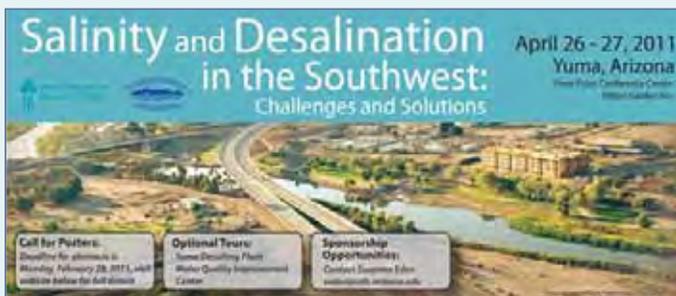




Connecting with the Community

WRRC faculty, students and staff were involved in numerous conferences, workshops, symposia, poster sessions, and more in 2011. The WRRC often serves as an organizing collaborator for these programs. A new collaborative effort was recently funded by the U.S.D.A. The Director of the Water Resources Research Center at Colorado State University, Reagan Waskom, was awarded a two-year planning grant for the project, *Addressing Agricultural Water Security in the Colorado River Basin: Planning for Water Research, Extension and Education*. Dr. Megdal serves as a co-PI for this effort, which has representatives from each of the seven Colorado River basin states. The purpose is to identify potential partners and opportunities to enhance water security for all sectors and to identify pilot projects that address legal, institutional and technical roadblocks to water conservation and sharing arrangements.

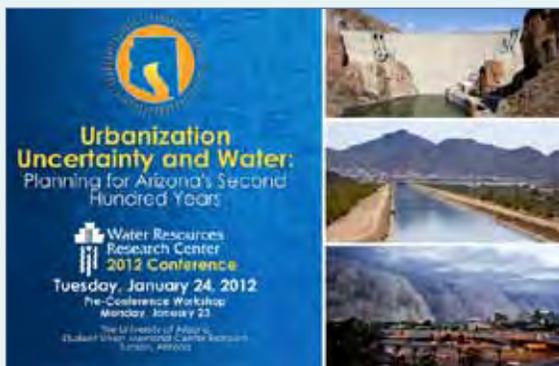
The WRRC's professional staff and students produced 32 publications and made 85 presentations statewide, nationally, and internationally in 2011. See Sections VIII, IX, and X in the appendix for WRRC students and personnel awards.



Annual Conference:

The 2011 conference, held in collaboration with the US Bureau of Reclamation, explored the role of desalination in expanding water supplies. The conference was held in Yuma at the Hilton Hotel and Pivot Point Conference Center. Participants heard the latest information on the Yuma Desalting Plant pilot run and learned from different perspectives on key water planning issues. Presenters spoke on current environmental concerns, regulatory matters, technical and cost challenges involved in desalination and other water planning issues. Approximately 175 people attended, including 20 local

K-12 teachers. Participants included attendees from 40 communities in Arizona and the US, and from Mexico and Israel. Poster presentations were discussed at the reception, sponsored by Befesa Water.



Planning for the 2012 Annual Conference, *Urbanization, Uncertainty and Water: Planning for Arizona's Second Hundred Years*, to be held on January 24 at the UA Memorial Student Union, took place throughout 2011. The conference was organized in cooperation with the Morrison Institute for Public Policy at ASU. The event followed up on the recent report, *Watering the Sun Corridor: Managing Choices in Arizona's Megapolitan Area*. The conference broadened the focus of the ASU report, encompassing the whole state. Two other recently released reports from the Grand Canyon Institute and the Water Resources Development Commission were also discussed.

Brown Bag Seminars:

The WRRC's brown bag seminar series offers two-way dialogue and community-university interaction. The focus is on topics of broad interest to academics from multiple disciplines and members of the water community. Sixteen Brown Bags were held in 2011 with an average attendance of 27 people. About 40 percent represented the community and 60 percent were from the University. See appendix (Table VII) for the full list of 2011 seminar dates and topics.



ARIZONA WATER RESOURCE

Arizona Water Resource Newsletter (AWR): The AWR newsletter focuses on state and regional water issues. In 2011, editorial duties passed to Susanna Eden. The look of the newsletter has been updated and more articles are written by guest authors and by Stephan Przybylowicz, the WRRC’s Graduate Assistant Outreach. Now published quarterly, it is sent free of charge to over 2,700 print and email subscribers both inside and outside of Arizona, including foreign countries. The publication regularly includes a feature article, a guest view, news briefs, sections on special projects, and a public policy column from the WRRC Director. Many issues include a four-page special supplement; the WRRC’s Environmental Programs sponsored a supplement in 2011. In the past year, several AWR articles have been picked up by UA’s College of Agriculture and Life Sciences Newslines. Below is a list of the key feature articles and authors for each of the four 2011 newsletters:



- *Winter 2011:* “Sustainable Water for All: Lessons in Hydrophilanthropy” by Stephan Przybylowicz; “Blue Ribbon Panel Finishes Work” by Chuck Graf, Senior Hydrologist, Water Quality Division, ADEQ
- *Spring 2011:* “Transboundary Aquifers: Water Wars or Cooperative Conservation?” by Stephan Przybylowicz; “Winners of the Joe Gelt Undergraduate Writing Competition: Joni Northam, UA; Deborah Englisch, NAU”
- *Summer 2011:* “Reclamation Completes Successful Pilot Run of the Yuma Desalting Plant,” by Jennifer McCloskey, US Bureau of Reclamation Yuma Area Office Manager; “WRRC Desalination Conference Highlights”
- *Fall 2011:* “Protecting Resources - Satisfying Consumers: New Corporate Water Strategies,” by Stephan Przybylowicz; “Through Dry Times,” by Alanna Riggs

ARROYO

Arroyo: The 2011 edition of the annual Arroyo, a newsletter focusing on a single topic of timely interest to Arizona, was published in the spring. *Desalination in Arizona - A Growing Component of the State’s Future Water Supply Portfolio* was written by Susanna Eden, Tim W. Glass, and Valerie Herman. The newsletter was handed out to participants at the WRRC’s Annual Conference on the same topic, and provided basic information on desalination technology, as well as a discussion of the opportunities and challenges presented by use of desalination to augment Arizona’s water supplies. The 2012 Arroyo, due in May, will cover Arizona-Mexico border water issues.

WRRC Fact Sheets:

The WRRC is developing a series of accessible two-page fact sheets focusing on important water issues in Arizona. The first two fact sheets will be summaries of past *Arroyo* content on water reuse and aquifer recharge. Graduate student Becky Witte produced drafts of the first two fact sheets. These resources should will be available in 2012.

Arizona Environmental Water Needs Assessment Report and Methodology Guidebook:

In early 2011, the WRRC released its Arizona Environmental Water Needs Assessment (AzEWNA) Report and Methodology Guidebook, authored by Joanna Nadeau and Sharon Megdal. These documents represent a technical and spatial assessment of almost 100 studies on environmental flow needs and responses. The AzEWNA was intended to increase public awareness of environmental flow needs, help policy makers understand the science, and identify information gaps. The Guidebook describes how to quantify Arizona’s environmental flows and provides tools for those designing environmental flow studies. Findings from the report were featured in the WRRC’s Fall 2011 AWR newsletter.

Annual Student Writing Opportunities

- In 2011, the Montgomery & Associates Summer Writing Internship Program selected Josue Sanchez Esqueda from an outstanding group of applicants. The internship is open to students from all three of Arizona's state universities. Josue, a student in the Department of Soil, Water and Environmental Science at the UA, sharpened his writing skills and increased his understanding of complex water issues. This yearly writing internship is supported by Montgomery & Associates, an Arizona-based consulting firm specializing in hydrology and water resource issues. The intern contributes to research and writing for the Arroyo.
- The Joe Gelt Student Writing Competition is being held again in 2011. Two winners, one each from UA and NAU, were selected. The UA student, Joni Northam, also won the Grand Prize of \$100. New emphasis has been placed on advertising to students and advisors. A registration process with reminders and writing tips has also been created to remind students of the deadline and maintain their interest. Twelve students registered, a substantial increase over the past two years. Each winner will receive a cash prize of \$50; the Grand Prize winner will receive \$100.

Other Outreach Events

- USGS Report introduced by Raul Grijalva: Congressman Raul Grijalva joined USGS hydrologists for a public briefing on Arizona groundwater on November 7, 2011 at the WRRC. Congressman Grijalva introduced Dr. James Leenhouts and Dr. Fred Tillman, who presented the recently released study Water Availability and Use Pilot: Methods Development for a Regional Assessment of Groundwater Availability, Southwest Alluvial Basins, Arizona. The USGS Groundwater Resources Program instituted this pilot program to evaluate groundwater resources in Arizona's alluvial basins. The principal products of the USGS report are updated groundwater budget information and a proof-of-concept groundwater-flow model.
- Simulation session with Frank van Weert on the Tragedy of the Commons game: In October, Bob Varady and Sharon Megdal hosted Frank van Weert of The International Groundwater Resources Assessment Centre. Van Weert, who has over 15 years of experience in groundwater resources management, hosted a session of the Tragedy of the Groundwater Commons Game. The WRRC session was open to observers. The simulation allowed students to learn together how to manage a common pool resource: shared groundwater. In the simulation, Mr. Van Weert divided the students into 10 "families"; each one had to make a decision about how much land to bring under production in a fictional agricultural community. Mr. Van Weert said the students who attended were "uncharacteristically cooperative." An article about the game will appear in the Winter 2012 AWR.



Susanna Eden, Ph.D., Coordinator of Applied Research, manages the WRRR Section 104(b) research grant program and the 104(g) nationally competitive grant program for the WRRC. She manages the summer internship at the WRRC for student writers, supervising the intern's research and writing for the Arroyo newsletter. Dr. Eden was lead author on a chapter, "Energy-Water Interdependencies and the Central Arizona Project" in *The Water-Energy Nexus in the American West*, published in 2011. She is co-organizer on a workshop, "Developing a Southwestern Research Agenda for Rainwater and Stormwater Harvesting Methodologies for Green Infrastructure and Low Impact Development," in conjunction with the AridLID 2012 Conference: Green Infrastructure and Low Impact Development in Arid Environments. With Jackie Moxley, she initiated the network of Rainwater Stormwater Professionals and wrote the successful proposal for a 2011 WaterSMART grant. She also implemented a writing contest for undergraduate students at the three Arizona universities and carried it into its third year. Winning articles in 2011 were published in the Spring AWR. She is co-editing a book based on the presentations at the Arizona-Israeli-Palestinian Water Management and Policy Workshop. A report of her research on decision support appeared in *Environmental Science and Policy* in January 2011. In late 2010, she assumed oversight of AWR and edited the 2011 issues.



Chocolate Fest

Each year, the WRRC hosts a “Chocolate Fest” in February for friends of the WRRC.

In 2011, the Fest was held on February 18; it was well-attended by University faculty and students, retired WRRC personnel, and friends from the community. The Fest, held yearly since 2004, provides a venue for socializing and sharing chocolate goodies among WRRC staff, supporters, collaborators and friends.

Online Presence



Web Site: In addition to WRRC news and events, the site carries *AWR* and *Arroyo*, as well as papers, presentations and links to other water sites. The site also offers information about WRRC activities such as the Annual Conference, the Brown Bag Seminar series, the Summer Internship competition and Writing Contest, and the 104(b) Small Grants Program. Staff profiles and information about WRRC products are also easily accessible. The WRRC web site is undergoing a complete redesign for an updated look and improved navigability. More than 12,000 visitors from around the world landed on the WRRC website in 2011.



WRRC Now on Facebook: Since its recent development the WRRC Facebook presence has increased substantially, with “likes” from users in the US, Egypt, Saudi Arabia, Palestine, the UK, and Australia; a weekly total reach (number of unique people who view any content on the page) of 58, including people in the US, Malaysia, Saudi Arabia, Israel, Australia, Argentina, and the Netherlands; and over 1,200 lifetime post views.

Administration and Support



John Polle serves as Web Manager and maintains the current site. Since starting work at the WRRC in August 2011, he has worked with a team on the redesign of the WRRC website, developing new functionality, ease of use and an updated user interface. In addition, he designed the logo, graphics, printed materials and website for the Annual Conference held in January 2012. He also worked with Dr. Eden to create web pages and an online enrollment form for the Joe Gelt Student Writing Competition.



Jane Cripps, Administrative Associate, is instrumental in implementing WRRC administrative and operational functions, including support for the Annual Conference, Brown Bag Seminars, the Arizona Water Resource newsletter, and website updates. She is completing her third term as Chair of the Staff Advisory Council for the UA College of Agriculture and Life Sciences.



LaVonne Walton, Business Manager, in addition to position duties, provides proposal quality control and assists with administration of the WRRR 104 program.

Greetings and Farewells



Jean E. McLain, Ph.D. became the WRRC's Associate Director in November 2011. She also has been appointed Associate Research Scientist at the WRRC and Associate Professor in the Department of Soil, Water and Environmental Science. Jean comes from the USDA-Agricultural Research Service, US Arid-Land Agricultural Research Center in Maricopa, Arizona, where she had been a Research Scientist since 2004. At the USDA, she directed research projects on human health and environmental risks of using reclaimed municipal wastewater for irrigation. Dr. McLain's USDA research also examined potential climate change impacts on microbiological nutrient cycling in Southwestern soils. Dr. McLain received her doctorate from Duke University in Microbial Ecology after earning a Master's Degree in Forest Science from Yale University and Bachelor of Science in Forestry from the University of Vermont. Dr. McLain has authored or co-authored more than 30 scientific publications and book chapters, and is an active member of the Soil Science Society of America and the American Society for Microbiology.

Grant funding stimulated several additional WRRC personnel changes in 2011. As a result of funding received from The Nature Conservancy and the Walton Family Fund, **Candice Rupprecht** now splits her time between Project WET and the C2E program. **Aaron Lien**, a former graduate research assistant at the WRRC, assumed a one-year position working on C2E, and **Ryn Shane-Armstrong** assumed a part-time position for Project WET.

Extension Agent **Kristine Uhlman**, who had directed the Non-point Education for Municipal Officials (NEMO) program funded by the Arizona Department of Environmental Quality, left in May 2011 for a groundwater Extension Specialist position at Texas A&M University. As a result, Professor Phil Guertin of the School of Natural Resources and the Environment (SNRE) has assumed NEMO program responsibilities and has moved NEMO personnel to SNRE facilities.



Budgetary Challenges

The UA continues to be affected by cuts to state appropriated dollars. In FY 2011, the UA and CALS absorbed a considerable portion of state budget cuts. The university and college capacity to absorb a disproportionate share of the budget cuts has been largely exhausted, meaning cuts for FY 2012 and beyond will likely have to be passed down to the units. We have been advised to prepare for a five percent budget cut for FY 2012. The WRRC has lost some grant funding, such as the City of Phoenix Arizona Project WET contract and appropriations for the Trans-boundary Aquifer Assessment Program. The NEMO program, along with its grants, also moved from the WRRC to a different CALS unit. Nevertheless, WRRC personnel have been successful in receiving new awards, several of which have come through the UA Foundation.

Appendix

Tables and Supplemental Information

The following pages of appendices contain background information on activities, projects and people mentioned in this report.

I. Research Program Overview	
RESEARCH PROJECTS	VALUE
Number of Projects	24
Mean Award for all Projects	\$21,393
Median Award for all Projects	\$9,900
Largest Project Award	\$130,876
Smallest Project Award	\$1,253
Total Project Awards	\$513,432

II. 2011 Proposals Selected for 104b Grants Program		
Characterization of Chelating Agents in Non-regulated Water Sources on Navajo Lands	NAU	\$10,000
The Effectiveness of Constructed Wetlands for Wastewater Treatment in a Semi-arid Climate	ASU	\$10,000
Iodinated Disinfection By-product Formation from Water Reuse Practices	UA	\$9,886

III. 104b Projects Funded in 2010		
Perfluorinated Compounds in Arizona Groundwater: Sources of Contamination	UA	\$10,061
Use of Fish as Integrative Samplers of Uranium and Lead Isotopes in the Colorado River	UA	\$9,900
Biochar Soil Amendments to Increase the Water Holding Capacity of Sandy, Arid Soils	UA	\$10,000
Bioremediation of Uranium Plumes with Nano-Scale Zero Valent Iron	UA	\$10,997
Sources and Transport of Nitrogen from Sky-Island Ecosystems to Groundwater Basins	UA	\$10,000

IV. WSP Funding

IV-A. Competitive Grants, Spring 2010-2011: 18 projects funded - \$531,474: WRRC staff were investigators on four of the projects receiving seed grant funding.

PI(s)	TITLE	AMOUNT
Kerry Schwartz and Holly Thomas-Hilburn	Communicating Scientific Results and Conclusions at a Multiage UA Forum	\$22,700
Gary Thompson (UA Agricultural and Resource Economics) and Sharon Megdal	Sensitivity of Residential Water Demand to Recent Price Increases in Urban Phoenix	\$19,233

Appendix

Tables and Supplemental Information

...cont'd WSP Funding- Competative Grants

PI(s)	TITLE	AMOUNT
Kristine Uhlman (WRRC) and Chris Eastoe (UA Geosciences):	Water Budgeting for a Rural Arizona Community	\$25,440
Mary Kay O'Rourke, Kristen Pogreba-Brown, and Marlene Dermody (UA College of Public Health), Kristine Uhlman (WRRC), Walt Klimecki (UA College of Pharmacy)	Engaging Rural Domestic Well Users in Water Quality Analyses	\$32,110

IV-B. Cost-Sharing: WSP provided cost-sharing to three projects funded by external agencies in FY2011.

- Changes in Storage/Distribution Systems, K. Lansey, WateReuse Foundation
- Arid Cities, A. Yool, C.Scott, A. Beuchler, S. Megdal, BOR WaterSMART
- Bio-analytic Techniques to Assess Human Impacts of Recycled Water, S. Snyder, WateReuse Foundation

IV-C. Student Fellowships Spring 2011 - \$85,000: A total of five graduate student and two undergraduate student fellows were funded through TRIF-WSP and managed at the WRRC for FY 2011/12.

NAME	DEGREE SOUGHT; ADVISOR	TITLE
Rachel Maxwell	BS, Soil, Water and Environmental Sciences; Advisor: Jon Chorover	Detection and Quantification of EDC/PPCPs in Source Waters Containing Dissolved and Colloidal Organic Matter
Brian Scott Sheppard	BS, Hydrology and Water Resources; Advisor: Martha Whitaker	The Effect of Fire on Rangeland Sustainability in the San Raphael Valley
Monica Ramirez	Ph.D., Soil, Water and Environmental Sciences; Advisors: Raina Maier, Janick Artiola, Mark Brusseau	Gardenroots: A Citizen Science Program to Empower Communities Neighboring Contamination
Kevin Ray	M.S., Agricultural and Resource Economics; Advisors: Satheesh Aradhyula, Gary Thompson	Sensitivity to Residential Water Demand to Recent Price Increases in Urban Phoenix Communities
Berenise Rivera	Ph.D., Soil, Water and Environmental Sciences; Advisor: Channah Rock	Analyzing Water Samples for Sources of Contamination Using PCR and qPCR
Lucia Rodriguez-Freire	Ph.D., Chemical and Environmental Engineering; Advisor: Reyes Sierra	Bioremediation of Arsenic-Contaminated Groundwater through the Formation of Arsenic Sulfide Minerals
Becky Witte	M.S., Hydrology and Water Resources; Advisor: Larry Winter	Probabalistic Risk Assessment to Determine Possible Failures in the Tucson, Arizona Water Supply

IV-D. Student Travel Awards: WSP provided funding for students to travel to present research at conferences.

- Three students presented at the World Water Congress in Recife, Brazil: Sabrina Aislinn Cotta, Political Science; Kelly Mott Lacroix, Arid Lands Studies; Lily House-Peters, Geography
- Four students presented at American Society of Civil Engineers - Environmental and Water Resources Institute conference in Palm Springs, CA: Gwendolyn Woods and Luis Huizar, Chemical and Environmental Engineering; Alicia Forrester and Elisabeth Lynn, Civil Engineering and Engineering Mechanics

Appendix

Tables and Supplemental Information

...cont'd WSP Funding- Student Travel Awards

- Two students presented at the Association of American Geographers (AAG) meeting in Seattle, WA: Lily House-Peters and Andrea Pritchard, Geography and Development

IV-E. WSP Funded WRRC Directed Initiatives: WRRC-WSP funds were used to continue to build the Conserve to Enhance Program. A pilot was launched and many partners and the public were engaged. “Incentives for rainwater harvesting” was a component added into the program as part of the conservation measures.

In addition, WSP co-sponsored three events, supplying logistical, funding, displays and/or programmatic support:

- ICOSSE (International Congress on Sustainability Science and Engineering), Water Reuse Workshop, *Global Implications for Industrial and Domestic Water Reuse*, Tucson, January 13-14, 2011;
- UA Science Café Lecture, Global Climate Change and the Southwest by Dr. Jonathan Overpeck, Phoenix, February 15, 2011; and
- WRRC Annual Conference, *Salinity and Desalination in the Southwest: Challenges and Solutions*, Yuma, April 26-27, 2011.

V. WEES Funding

V-A. Competitive Funding, 2011-2012: WEES awarded 14 Grants to UA research projects related to water, energy, and the environment for a total of \$482,000.

PI(s)	TITLE
Paloma Beamer, Kelly Reynolds (Public Health), Nolan Cabrera (Education)	Risk perception, Drinking Water Source and Quality in a Low-Income Latino Community Along the US- Mexico Border
Chris Castro (Atmospheric Sciences), Peter Troch (Hydrology and Water Resources)	Feasibility of Dynamically Downscaled Water Resource Projections for the Colorado and Rio Grande River Basins
Chris Choi (Agriculture and Biosystems Engineering), Robert Collier (Animal Sciences)	Sustainable Dairy Production in Arizona Using Innovative Cooling Systems
Alex Cronin (Physics), Nate Allen (Biosphere 2), Gautam Gowrisankaran (Economics), Young-Jun Son (Systems and Industrial Engineering), and Mike Leuthold (Atmospheric Sciences)	Smart Grids for Water and Energy: Watergy
Sandy Dall’erba (Geography and Development), Francina Dominguez and Yolande Serra (Atmospheric Sciences)	The Impact of Climate Change on Arizona’s Agriculture: The Ricardian Approach Revisited
Kirstin Engel (Law), Ardeth Barnhart (Institute of the Environment)	A Regional Approach to Renewable Energy Portfolio Standards in the Western States: An Economic and Policy Analysis
Ty Ferre (Hydrology and Water Resources)	Improved Hydrogravimetry to Measure Water Storage Change and Subsurface Hydraulic Properties
Karl Flessa (Geosciences), Laura Lopez-Hoffman (Natural Resources and the Environment/Udall Center for Studies in Public Policy)	Enhancing Trans-border Ecosystem Services through Active Management: The Ciénega de Santa Clara

Appendix

Tables and Supplemental Information

...cont'd WEES- Competitive Funding, 2011-2012

PI(s)	TITLE
Roberto Guzman and Jerker Porath (Chemical and Environmental Engineering)	Development of Engineered Reversible and Regenerable, High Capacity Adsorbents for Sustainable Removal of Arsenic from Contaminated Waters
Miranda Loh and Mary Kay O'Rourke (Public Health), Walter Klimecki (Pharmacy)	Variability of Arsenic Exposure and Chronic Disease Response
Doug Loy (Materials Science and Engineering), Peiwen Li (Aerospace and Mechanical Engineering)	New Acetal-Modified Polymers for High Energy Density, Solid State Storage of Methanol for Direct Methanol Fuel Cells
Oliver Monti (Chemistry and Biochemistry) and Sumit Mazumdar (Physics)	Doubling the Performance of Organic Solar Cells: Utilization of Spin Triplet Excitations
Shane Snyder (Chemical and Environmental Engineering), Ian Pepper (Soil, Water and Environmental Science)	Use of Real-time Surrogates and Indicators for Monitoring Chemical and Water Quality Parameters
Armin Sorooshian (Chemical and Environmental Engineering/ Atmospheric Sciences), Paul Brooks, Tom Meixner and Adrian Harpold (Hydrology and Water Resources)	Linking Dust Aerosol and Snow Melt in the US Southwest

V-B. Speaker Funding Awards, 2011-2012: 4 proposals were selected for funding to \$5,800 to bring 6 distinguished speakers to UA.

LECTURES	ORGANIZERS
Anthony Ingraffea, Department of Civil and Environmental Engineering, Cornell University, on hydraulic fracturing	Southern Arizona Geographers Association (representing students from the School of Geography and Development) and the Natural Resources Graduate Student Organization (representing students from the Natural Resources and the Environment)
Lorena Rios, Assistant Professor, Chemistry, University of Wisconsin, Superior, on persistent organic pollutants adsorbed on plastic debris from the marine environment	Soil, Water, and Environmental Science and Chemistry and Biochemistry.
Michael Dorsey, Environmental Studies Department, Dartmouth College, on climate justice versus eco-markets	Natural Resources and the Environment
A three-part lecture series on environmental science communication: <ul style="list-style-type: none"> • Susan Joy Hassol, director of Climate Communication, how scientists communicate; • Andrew Revkin, Senior Fellow for Environmental Understanding at Pace University, how journalists translate scientific information, and • Jon Krosnick from the Department of Humanities and Social Sciences at Stanford University, how environmental science is understood by the public 	Geosciences, Geography and Development, and English

Appendix

Tables and Supplemental Information

V-C. Workshop Funding Awards, 2011-2012: 7 proposals were selected for funding to host workshops for a total of \$30,900.

WORKSHOP TITLE	PI(s)
Engineers Without Borders USA Mountain Region Training Workshop	Andrea Prichard, Geography and Development
Applying Traditional Knowledge Toward Water Management and Sustainability Today: Planning for a Southern Arizona Center and Oasis Reconstruction	Suzanne Fish, Paul Fish (Anthropology/AZ State Museum), Gary Nabhan (Southwest Center), Mitchell Pavao-Zuckerman (Biosphere 2)
Solar Energy Conversion and Related Renewable Energy Science and Technologies	Neal Armstrong, Dan Moseke (Chemistry and Biochemistry)
Developing a Southwestern Research Agenda for Rainwater and Stormwater Harvesting Methodologies for Green Infrastructure and Low Impact Development; in conjunction with the AridLID 2012 Conference: Green Infrastructure and Low Impact Development in Arid Environments, March 27-29 AridLID.org	Susanna Eden (WRRC), Martin Yoklic (Soil, Water and Environmental Sciences)
Southwest Wildfire Hydrology and Hazards Workshop	Steve DeLong (Biosphere 2)
Controlled Environment Agriculture for Food Production and Environmental Stewardship Short Course	Gene Giacomelli (Agricultural and Biosystems Engineering), Patricia Rorabaugh (Plant Science), Kevin Fitzsimmons (Soil, Water and Environmental Science)
Conflict and Collaboration in Community and Environmental Decision Making	Iris Patten (Landscape Architecture and Planning)

VI. APW-WIP Mentor Scientists

MENTOR SCIENTISTS	DEPARTMENT MAJOR
Cash Veo	Agricultural Education
Todd Gaston	Agriculture and Resource Economics
Brittany Ciancarelli	Atmospheric Sciences
Gwendolyn Woods	Chemical and Environmental Engineering
Javier Miguelena	Entomology
Melissa Mauzy	Geography and Development
Drew Laskowski	Geosciences
Kristen Neff	Hydrology and Water Resources
Stephan Przybylowicz	Information Resources and Library Science
Desniege Hallbert	Landscape Architecture
Justin Mapula, Spencer Sussman, Carl Lundblad, Greg Butler, Gerene Garcia, Ashwin Naidu, Brit Oleson, Kirsten Dillon, and Alex Arizpe	Natural Resources and the Environment
Corin Hammond	Soil, Water and Environmental Science

Appendix

Tables and Supplemental Information

VII. Brown Bag Seminar Schedule - 2011

DATE	SPEAKER	TITLE
01/19	Walter Piegorsch, Ph.D., Professor and Chair, Graduate Interdisciplinary Program (GIDP) in Statistics, UA	Statistical Risk Benchmarking in Environmental Risk Assessment
01/26	Joe Abraham, Ph.D., Director of the UA Office of Sustainability	UA Campus Sustainability Leadership, Resources, and Priorities – What’s New, and How to Get Involved
02/02	Kurt Schnier, Ph.D., Georgia State University Department of Economics	Economics in Action: Policy Relevant Research
02/23	Joanna Nadeau, Research Analyst, WRRC, UA	Securing Water for the Environment: An Update on Conserve to Enhance
02/24	Linda Fernandez, Ph.D., Associate/Full Professor, Agricultural and Resource Economics, UA	Economic Analyses of Policy Options for Solving Water Challenges
03/08	Kimberlee Mulhern, Chief, Environmental and Natural Resources Division, US Army Corps of Engineers	Successfully Reducing Your Groundwater Footprint and Second and Third Order Effects
03/23	Warren Tenney, CAP Board Member and Assistant General Manager, Metro Water	Arizona’s Water Resources 101: How Arizona is Planning and Investing in its Most Important Resource
04/13	Robert Lang, Graduate Student, School of Art, UA; Daniel Cheek, Graduate Student, School of Art, UA	Water Stewardship at PepsiCo: Looking In, Out, and Beyond
05/04	Liese Dallbauman, Director, Water Stewardship, PepsiCo	Water Stewardship at PepsiCo: Looking In, Out, and Beyond
07/29	Brittany Choate, Water Resources Research Center, UA Suzanne Shields, P.E, Pima County Regional Flood Control District and Leslie Ethen, Office of Conservation and Sustainable Development, City of Tucson	Riparian Preservation and Restoration and Large-scale Projects in Tucson and Pima County
08/17	Adam Springer, Ph.D., School of Natural Resources and the Environment, UA	Drivers of Household Water
09/15	Mark Marikos, Staff Technician - Utilities Management and Services, Facilities Management , UA Jaclyn Mendenhall, Undergraduate, Department of Hydrology and Water Resources, UA, and former Research Intern for the Office of Sustainability	Water Use at the University of Arizona – Sources, Uses, Costs, Challenges and Opportunities and Estimating the Energy and Greenhouse Gas Emissions Embedded in Metered Water at the University of Arizona
09/21	Lisa Shipek, Watershed Management Group; B.J. Cordova, Tucson Clean and Beautiful, Inc.; Kendall Kroesen, Tucson Audubon Society; Trevor Hare, Sky Island Alliance	Urban Watershed Riparian Restoration and Tucson Clean and Beautiful and Restoration in the Sky Islands
09/27	Eve Halper, Ph.D., Tucson Field Office, US Bureau of Reclamation	Can Parks Inhibit Outdoor Water Use?
11/07	James Leenhouts, Ph.D., Interim Director, Water Science Center; Fred Tillman, Ph.D., Research Hydrologist, US Geological Survey	Water Availability and Use Pilot: Methods Development for a Regional Assessment of Groundwater Availability, Southwest Alluvial Basins, Arizona, with Introduction by Congressman Raúl Grijalva
11/15	Nadia Madden, Energy-Water Project Associate, Climate and Energy Program, Union of Concerned Scientists, Cambridge, MA; Jonathan Overpeck, Ph.D., Co-Director, Institute of the Environment, Professor, Departments of Geosciences and Atmospheric Sciences, UA	Freshwater Use by U.S. Power Plants: Electricity’s Thirst for a Precious Resource

Appendix

Tables and Supplemental Information

...cont'd Brown Bag Schedule 2011

DATE	SPEAKER	TITLE
11/30	Steve DeLong, Ph.D., Lead Scientist, Assistant Research Professor, Biosphere 2, UA	Interdisciplinary Earth Science in a Controlled Environment: The Biosphere 2 Landscape Evolution Observatory
12/09	Tom Buschatske, Assistant Director, Arizona Department of Water Resources	Issues and Opportunities in Arizona's Water Resources Planning and Management

VIII. WRRC Students

- **Jessica Chase**, Student Assistant for Arizona Project WET, is now a senior in the Eller College of Business. She will graduate with a Bachelor of Science in business management in May 2012. Jessica has served as the office manager assistant for APW since she was a freshman. Jessica maintains various APW inventories for check-out in addition to weekly and monthly programming. She assists the office manager with P-card purchasing, record keeping, travel requests, and ordering and maintaining vendor lists for APW. She assists in updating the APW website and maintains the APW participant database, evaluation database and listservs. Jessica also prepares all workshop materials.
- **Brittany Choate**, a Master's student in Soil, Water and Environmental Science with an expected graduation date of May 2012, presented a poster in November 2011 at UA's annual campus-wide Student Showcase on the WRRC's C2E Tucson Pilot program. Ms. Choate's presentation was awarded 2nd place in the Agriculture and Environmental Sciences Graduate Student division. At the annual Environmental Research Grad Blitz in November 2011, she won the Judges' Choice award for best presentation linking science to society.
- **Jenna Cleveland** is a graduate student seeking an MS degree in planning, with expected graduation in December 2013. She is supported by the Bureau of Reclamation WaterSmart grant at the WRRC and has contributed to an article published in the ARCSA quarterly newsletter. She also supports the new Rainwater-Stormwater Professionals Network and is involved in organization of the workshop planned for March 2012 to set a water harvesting research agenda.
- **Brian Cunningham** is a Master of Science student in the Water, Society and Policy degree program, with an expected graduation date in Spring 2013. He is carrying out research for Dr. Megdal on drought management by Arizona's Native Tribes.
- **Marissa Isaak** is a doctoral student in the Department of Geography, Minor in Arid Lands, with an expected graduation date of May 2014. She has worked at the WRRC on water management in Israel. In 2011, she made presentations on *Prospects for Desalination in Israel* and *Playing Politics at the World Bank: The Red-Dead Canal*. In addition, Ms. Isaak received the Social and Behavioral Sciences Research Institute Development Award for grant development and the AICE/Schusterman Israel Scholar Award for continued work on research related to Israel.
- **Kelly Mott Lacroix**, Ph.D. student in Arid Land Resource Sciences with expected graduation date May 2014, supports the WRRC's research on environmental water needs. She presented *Assessing Water Supply Vulnerability in a Water Scarce State: The Arizona Water Sustainability Evaluation* at the International Water Resources Association 14th World Water Congress in Brazil, and *Arizona Water Management Along the Adaptive Cycle: What Can the Ebb of Water Governance Teach us About Future Flows?* at the 2011 Annual Meeting of the Arizona Hydrological Society in Flagstaff. In addition, she received a 2nd Place CAP Award for Water Research competition and a H.E. Carter Travel Award for travel to IWRA Water Congress.
- **Yancy Lucas**, the WSP Graduate Assistant Outreach, graduated in Spring 2011 with a Master of Planning Degree.
- **Martin Picazzo**, the WRRC's undergraduate student for IT support, is a business student in the management information systems program, expected graduation date 2014.
- **Jacob Prieto** is a Master's Degree student in hydrology and water resources. He worked with the Earth Camp program after his service in Americorps during the 2010-11 school year.
- **Stephan Elizander Przybylowicz**, the WRRC Graduate Assistant Outreach, is a graduate student in the department of information resources and library science, expecting to graduate in May 2012. He was the author of the main AWR feature article and produced much of the newsletter text for all four AWR 2011 issues. Mr. Przybylowicz was also responsible for developing the WRRC's Facebook presence. In Spring 2011, he was a Graduate Professional Student Council travel grant awardee.
- **Rochelle Reuter**, an undergraduate environmental studies major with expected graduation date May 2013, handles reception and multiple administrative duties.
- **Tiffany Tom**, a second year law student, worked for Dr. Megdal during the summer of 2011 on the paper
- **Lisa Watanabe**, an undergraduate student in pre-visual communication with an expected graduation date of May 2014, is responsible for the updated design for the AWR and does layout for the WRRC's newsletters.

Appendix

Tables and Supplemental Information

... cont'd WRRC Students

- **Becky Witte** is a Master's Degree student in hydrology and water resources with an expected graduation date of May 2013. In 2011, Becky supported work on 104 Program reporting and the content of the newly initiated WRRC Fact Sheets.

IX. Arizona Project WET Students

- **Spencer Sussman**, M.S. student in the School of Natural Resources, expects to graduate in May 2012.
- **Rex De Roulhac**, undergraduate (History, Spanish), expects to graduate in May 2012.
- **Brian Underwood**, undergraduate (Planning), expects to graduate in May 2012.

X. WRRC Personnel Awards, Honors and Recognition

In 2011, WRRC personnel were recipients of several awards and honors. Several of the more prestigious awards are below:

- **Sharon Megdal** was awarded a Lady Davis Fellowship to fund her one-month sabbatical stay in Israel.
- **Sharon Megdal** was elected to the board of directors of the National Institutes for Water Resources (NIWR), the association of water institutes/centers authorized by the federal Water Resources Research Act.
- During the Fall 2011 semester, **Sharon Megdal** was voted an affiliated faculty for the Arizona Center for Judaic Studies and the James E. Rogers College of Law.
- In Spring 2011, **Jackie Moxley** was elected to serve as Appointed Professionals' representative on EcoOps, a UA employee group formed to promote campus sustainability. Her elected position includes membership on the President's Advisory Council for Environmental Sustainability.
- **Susanna Eden** was confirmed as a CALS representative to the UA Appointed Professionals Advisory Council.
- **Kerry Schwartz** was presented the Individual Program Leadership Gold Award in recognition of exemplary leadership of an individual natural resources program by the national Association of Natural Resource Extension Professionals in 2011.
- At the Sustaining the Blue Planet International Water Education Conference, **Kerry Schwartz** received a One World One Water Award for exemplary service over the last 12 years. This award was presented at the September 2011 conference with 40 countries represented.
- At the Sustaining the Blue Planet International Water Education Conference in September 2011, with 40 countries represented, Arizona Project WET had 5 presentations accepted

and presented them all. No other state program made any presentations. The Presentations included:

- "*Destination Inquiry: Paddling Upstream*", Pamela Justice and Mary Ann Stoll
- "*Grounding Water: Building Student Understanding Through Multi-Modal Assessment*", Holly Thomas-Hilburn and Kerry Schwartz
- "*STEM Subject Integration: Meeting the Need with Tangible Programming*", Kerry Schwartz, Candice Rupperecht and Holly Thomas-Hilburn
- "*A Different Animal: Attracting Corporate and NGO Sponsorship*", Kerry Schwartz and Tasha Krecek-Lynch
- "*Riding the Wave of Student-Driven Inquiry: Terror or Treasure*", Mary Ann Stoll and Pamela Justice
- Student Awards:
 - **Marissa Isaak** received the Social and Behavioral Sciences Research Institute Development Award and the AICE/Schusterman Israel Scholar Award for continued work on research related to Israel.
 - **Kelly Mott Lacroix** received the CAP Award for the 2011 Student Research Paper Competition, and both a H.E. Carter Travel Award and Water Sustainability Program travel grant to present at the IWRA Water Congress in Brazil. Kelly's connection to the WRRC and the Nina Mason Pulliam Charitable Trust grant was featured in the just-released Annual and Endowment Report for the UA Foundation.
 - For her poster on C2E, **Brittany Choate** was awarded 2nd place in the Agriculture and Environmental Sciences Graduate Student division at UA's annual campus-wide Student Showcase and won the Judges' Choice award for best presentation linking science to society at the annual UA Institute for the Environment's Environmental Research Grad Blitz.
 - **Stephan Elizander Przybylowicz**, was a Graduate Professional Student Council Travel Grant Awardee.

Appendix

Tables and Supplemental Information

WRRC 2011 Annual Report Financial Data, 01/01/2011 – 12/31/2011

SOURCES OF REVENUES	AMOUNT
Basic 104(b) Award	\$107,838
USGS 104(g) Grant Awards	\$1,474
USGS IWR Grant Awards	\$160,146
Other Federal Sources (Grants & Contracts)	\$477,479
State Appropriation (Line Item)	\$498,046
Other State Sources (Grants & Contracts)	\$506,436
University Funds	\$278,935
Foundation Funds	\$399,034
Private Sector Sources (Grants & Contracts)	\$486,345
All Other Direct Funds	\$582,466
	Sub-Total Revenue
	\$3,498,199
Pass-Through Funds (104b, 104g, IWR, Foundation Monies)	\$624,914
	Total Revenue
	\$2,873,285
EXPENDITURES	
Personnel Costs	\$864,350
Stipends, Lecturer Fee's, Participant Support, Temporary Labor	\$39,621
Sub-Contractual Agreements	\$100,000
Printing & Publication	\$30,101
Communication	\$24,706
Telecommunications Upgrade Project	\$11,324
Educational Supply	\$37,158
Field and Research Supply	\$6,159
Office Supply	\$10,384
Travel	\$59,214
Conference Registration Fees	\$8,070
Membership Dues	\$5,371
Building and Vehicle Rental	\$38,273
Business Meetings	\$ 8,655
Equipment	\$20,547
	Sub-Total Expenditures
	\$1,263,933
EXPENDITURES (COST OF DOING BUSINESS)	
Personnel Employee Costs	\$271,157
Administrative Service Charges & Indirect Costs	\$72,823
	Total Expenditures
	\$1,607,913
	2012 Personnel and Operations Encumbrances
	\$596,505

Appendix

Tables and Supplemental Information

	2011 Revenue Available at 12/31/2011	\$668,867
CARRYOVER BALANCE		AMOUNT
Basic 104(b) Award		\$7,043
USGS 104(g) Grant Awards		\$0
USGS IWR Grant Awards		\$0
Other Federal Sources (Grants & Contracts)		\$164,375
State Appropriation (Line Item)		\$12,616
Other State Sources (Grants & Contracts)		\$59,609
University Funds		\$111,520
Foundation Funds		\$144,501
Private Sector Sources (Grants & Contracts)		\$73,349
All Other Direct Funds		\$95,854

Explanatory Information - Sources of Revenue

(Includes all monies received in 2011 and monies available in our budgets at January 1st, 2011)

Basic 104B Grant: This 5 year Cooperative Agreement is funded annually at of \$92,335. We receive this federal funding as Arizona's State Water Resources Research Institute. The WRRC funded three research grants this year (see Section II Part I (a)). The remaining monies were used to support administration of the 104(b) program and Information Transfer personnel and outreach activities. There are funds carrying over into calendar year 2012 as the grant period is March 1st through February 29th, 2012.

USGS 104(g) & USGS IWR Grant: These awards are processed through the WRRC as required by USGS policy. Arizona had one of each award this year (see Section II Part 1(a)). Both grants were awarded to UA Researchers. The 104(g) grant included a small portion of the budget was used to support 104(g) program administration in WRRC.

Other Federal Sources (Grants & Contracts): This section includes all monies received for competitive national federal grants and cooperative agreements. Most Federal grants have a multi-year award period. Revenue is reported in the first year of the grant and expenses are recorded in each year of the grant. This often will leave a large amount of revenue unspent at the end of the calendar year.

State Appropriation: This includes revenue provided by the State of Arizona, College of Agriculture and Life Sciences. Partial funding is provided for administrative salaries, operations and travel. In 2011 we had a budget recession of \$12,062 and in 2012 a 5% or \$14,000 budget cut is anticipated.

Other State Sources (grants & contracts): This includes revenues received from local, county, state and governmental agencies. We received funding from CAP (Central Arizona Project), City of Tucson, and Arizona Department of Environmental Quality (ADEQ).

University Funds: These monies include all revenue accrued by the WRRC from Publication Sales, Annual Conference and Miscellaneous Services.

Foundation Funds & Private Sector Sources (Grants & Contracts): These sections include competitive and charitable grants & gifts received from non-profit organizations and private individuals. We received major grant awards from The Arizona-Sonora Desert Museum, the Nature Conservancy, The Nina Mason Pulliam Charitable Trust, The Walton Family Foundation and the Abbott Fund.

All Other Direct Funds: This section includes revenue from the State Technology Research Initiative Fund (TRIF), a state tax derived fund supporting various programs in Arizona universities. The WRRC hosts part of the TRIF funded Water, Environmental and Energy Solutions (WEES) Water Sustainability Program.

Pass-Through Funds: This amount represent monies awarded to the WRRC and forwarded to other Departments and Universities (Including 104(b), 104(g), IWR, NEMO and TRIF monies).

Appendix

Tables and Supplemental Information

Expenditures

Personnel Costs: Salaries, Wages and Supplemental Compensation paid for WRRC employees and University faculty. Faculty=16.64%, Appointed Personnel=23.49%, Classified Staff=34.20%; Graduate Students=10.70%, Undergraduate and Student Hourly Wages=14.97%.

Stipends, Lecturer's Fees, Participant Support and Temporary Labor: This section includes stipends paid to University graduate students and Arizona Project WET teacher professional development workshop participants and organizers, conference and lecturer fees and temporary labor costs.

Sub-Contractual Agreements: Three sub-contracts in 2011: one each with ASU and NAU of \$10k each from the 104(b) program and one with the International Boundary Water Commission for \$80k for the Transboundary Aquifer Assessment Program.

Printing & Publication: Included in this section are costs of printing various publications including our quarterly newsletter (AWR) and the annual Arroyo, conference posters, fact sheets, water cards, business cards, and promotional materials. Also included are our copier page charges and paper costs.

Communication: This section includes cost for Annual Network FTE communication charges (\$766 per 1.0 FTE or \$9,958), toll charges, conference calls, eliminate sessions, cellular phone services, networking, postage and express shipping costs.

Telecommunications Upgrade Project: To facilitate the conversion of the old phone system to a new system with University prefixes (621 & 626) monies were spent to upgrade the telecommunication facilities in the building, install new phone lines, purchase new phone equipment.

Educational Supply: This amount represents Arizona Project WET purchases to facilitate water festivals, classroom presentations, Sweetwater Wetlands presentations and professional development workshops, seminars and meetings.

Field and Research Supply: These monies were used in support of the Arizona NEMO program for physical supplies necessary to conduct field and laboratory research.

Office Supply: Costs included in this section are general office supplies, toner cartridges, meetings and conference supplies.

Travel: Expenses include local, state, national and international travel to present projects and research at various conferences, meetings and workshops, to meet with stakeholders in other parts of the country and to attend the National Institutes of Water Resources annual meeting (Washington DC).

Conference Registration Fees: Cost for WRRC employees to attend conferences for information gathering, training or to present WRRC projects.

Membership Dues: Membership dues to NIWR and UCOWR are required to maintain the WRRC Status (\$4,245) and membership dues for personnel for professional organizations relevant to their employment.

Building and Vehicle Rental: Expenses in this section include facility rental for the WRRC annual conference, Arizona Project WET workshops and vehicle rental expense for Arizona Project WET's Summer Earth Camp project.

Business Meetings: Included in this section are costs for WRRC general meeting refreshments, food for annual WRRC conference, lunch and dinner meetings with collaborators and stakeholders.

Equipment: Costs for computers (including software), data processing, and research equipment (NEMO) purchased at and for the WRRC.

Expenditures (Cost of Doing Business)

Personnel Employee Cost: This section includes the cost of employee fringe benefits, background checks and required employee training.

Administrative Service Charges and Indirect Costs: This section represents the costs incurred to the University to process checks and deposits and the Indirect cost charged on research projects.

Appendix

WRRC Publications (alphabetical by author(s), alphabetical by title)

- Browning-Aiken, Anne, C. A. Scott, R. G. Varady, and S. B. Megdal, Cooperation for Transboundary Water Management, *INBO (International Network of Basin Organizations) Newsletter*, May 2011, Vol. 19, p. 20. At <http://www.inbo-news.org/pub/INBO-19/>
- Cleveland, Jenna, S. Eden and J. Moxley, WRRC Drafting RWH Guidelines, *ARCOSA Quarterly Newsletter*, Dec. 2011. Conserve to Enhance Program Snapshot, *Arizona Water Resource*, Water Resources Research Center, Winter 2011, Vol. 19, No. 1.
- Eden, Susanna, C.A. Scott, M. Lamberton, and S.B. Megdal, Energy-Water Interdependencies and the Central Arizona Project, *The Water-Energy Nexus in the American West*, Doug Kenney and Robert Wilkinson, Eds., Edward Elgar Publishing, submitted September 2010, forthcoming, 2011.
- Eden, Susanna, T.W. Glass, V. Herman, Desalination in Arizona - A growing component of the state's future water supply portfolio, *Arroyo*, Water Resources Research Center, Spring 2011.
- Kiser, Madeline S.B. Megdal, M. Stratton, V. Vasquez and C. Zucker, *Regional Water Assessment Task Force "Think Tank" Report*, August 2011. Available at www.pagnet.org
- Megdal, Sharon B., Back to Fundamentals – On Economics and Water Pricing, *Arizona Water Resource*, Water Resources Research Center, Spring 2011.
- Megdal, Sharon B., Conference Covers the Five Es of Desalination, *Arizona Water Resource*, Water Resources Research Center, Summer 2011.
- Megdal, Sharon B., The Role of the Public and Private Sectors in Water Provision in Arizona, USA, *Water International*, Special Issue on Water Governance: The Public-Private Debate, invited paper, accepted with minor revisions (Resubmitted, October 2011), forthcoming, 2012.
- Megdal, Sharon B., Uncertainty: Are We Running Out of Water?, *Arizona Water Resource*, Water Resources Research Center, Winter 2011.
- Megdal, Sharon B. and J. Lara Alvarez, Achieving Water Policy Objectives through Water Pricing: A Case Study of Arizona's Decentralized Approach to Water Provision, Shared Borders, *Shared Waters: Israeli, Palestinian and Lower Colorado River Basin Water Challenges*, Edited by Sharon Megdal, R. Varady and S. Eden, Forthcoming pending final approval of UNESCO Press, 2011 or 2012.
- Megdal, Sharon B. and C. A. Scott, The Importance of Institutional Asymmetries to the Development of Binational Aquifer Assessment Programs: The Arizona-Sonora Experience, *Water*, Special issue on Water Policy, 3 (3), 949-963, 2011.
- Megdal, Sharon B., J. Nadeau, and R. Malloy, Ed., Taylor and Francis Group, Water Planning for Growing Southwestern Communities, *Design with the Desert*, Forthcoming, 2011.
- Megdal, Sharon B., J. Nadeau and T. Tom, The Forgotten Sector: Arizona Water Law and the Environment, *Arizona Journal of Environmental Law and Policy*, Vol. 1, No. 2 (2011), pp.243-293. Available at <http://www.ajelp.com/>
- Megdal, Sharon, R. Senci3n, C.A. Scott, F. D3az, L. Oroz, J. Callegary, and R. Varady. Institutional Assessment of the Transboundary Santa Cruz and San Pedro Aquifers on the United States-Mexico Border, *Proceedings of the UNESCO-IAH-UNEP Conference on Transboundary Aquifers: Challenges and New Directions* (ISARM 2010), Paris, 6-8 December 2010, forthcoming 2011.
- Megdal, Sharon, R. Varady and S. Eden, *Shared Borders, Shared Waters: Israeli, Palestinian and Lower Colorado River Basin Water Challenges*. Forthcoming pending final approval by UNESCO Press, 2012.
- Megdal, Sharon, R. Varady and S. Eden, *Shared Borders, Shared Waters: Israeli, Palestinian and U.S. Southwestern Lessons in Water Resource Management*, UNESCO Press, Forthcoming, 2011.
- Megdal, Sharon, R. Varady, P. Vandervoet, and C. Scott, Water Allocation under Uncertainty: Groundwater and Effluent in the United States-Mexico Transboundary Santa Cruz River Basin, *The Third United Nations World Water Development Report (WWDR4) Case Studies Volume*, UNESCO, forthcoming.

Appendix

WRRC Publications (alphabetical by author(s), alphabetical by title)

- Merla, Andrea, H. Treidel, and S. B. Megdal, *GEF Transboundary Waters Assessment Programme (TWAP) Methodology and Execution Arrangements: Transboundary Aquifers Methodology*, Final Draft, UNESCO-IHP, IGRAC, WWAP, December 2010.
- Nadeau, Joanna, and S.B. Megdal, *Arizona Environmental Water Needs Assessment Report*, WRRC, 2011.
- Nadeau, Joanna, and S.B. Megdal, *Arizona Environmental Water Needs Assessment Methodology Guidebook*, WRRC, 2011
- Nadeau, Joanna, S.B. Megdal, C. Rupprecht and B. Choate, Arizona Environmental Water Needs Assessment Report and Methodology Guidebook, Insert, *Arizona Water Resource*, Water Resources Research Center, Vol. 19, No 4, Fall 2011.
- Nadeau, Joanna, S.B. Megdal, C. Rupprecht, B. Choate, E. Brott and L. Shipek, Testing the Waters: Tucson, Arizona, Links Water Conservation with Environmental Benefits, *Journal of the American Water Works Association*, Vol. 104, No 2. Forthcoming, February 2012.
- Pieters, Kevin and K.Schwartz, School Water Audit Program Business Plan. Arizona Project WET Advisory Council and Stakeholders, 2011.
- Przybylowicz, Stephan, Protecting Resources - Satisfying Consumers: New Corporate Water Strategies, *Arizona Water Resource*. Water Resources Research Center. Fall 2011.
- Przybylowicz, Stephan, Sustainable Water for All: Lessons in Hydrophilanthropy, *Arizona Water Resource*. Water Resources Research Center. Winter 2011.
- Przybylowicz, Stephan, Transboundary Aquifers: Water Wars or Cooperative Conservation?, *Arizona Water Resource*. Water Resources Research Center. Spring 2011.
- Schwartz, Kerry, H. Thomas-Hilburn, and A. Haverland, Grounding Water: Building Conceptual Understanding through Multimodal Assessment, *Journal of Geoscience Education*, 59, 1-12, 2011.
- Scott, Christopher, S.B. Megdal, L.A. Oroz, J. Callegary, and P. Vandervoet, Assessment of the United States – Mexico Santa Cruz Transboundary Aquifer Facing Climate Change and Growth in Urban Water Demand, *Climate Research*. Revised and resubmitted, September, 2011.
- Thomas-Hilburn, Holly and K. Schwartz, Arizona Project WET Water Festivals: A Summative Evaluation, *Bureau of Reclamation Final Report*, 12 p, 2009.
- Vandervoet, Prescott L., S.B. Megdal, C.A. Scott, Ed. G. Cordova, J. Dutram, B. Lara, and J.Rodriguez, Los Acuíferos Transfronterizos Santa Cruz y San Pedro de Arizona y Sonora: Estado Actual y Creación de Bases de Datos, *Fortaleciendo el Dialogo Social: el desarrollo humano transfronterizo en la región Sonora-Arizona*. Universidad de Sonora. Hermosilo, Sonora (in review).
- Varady, Robert G., C.A. Scott, and S.B. Megdal, Transboundary Aquifer Institutions, Policies, and Governance: A Preliminary Inquiry, *Proceedings of the UNESCO-IAH-UNEP Conference on Transboundary Aquifers: Challenges and New Directions (ISARM 2010)*, Paris, 6-8 December 2010, forthcoming 2011.

Appendix

WRRC Presentations (alphabetical by presenter(s), chronological by date)

- Choate, Brittany, *University of Arizona Graduate Research Blitz*, Tucson, AZ, February 2011.
- Choate, Brittany, *University of Arizona Graduate Research Blitz*, Tucson, AZ, November 2011.
- Choate, Brittany, J.B. Nadeau, and C. Rupprecht, *University of Arizona Student Showcase*, Tucson, AZ, November 2011.
- Isaak, Marissa, *Association of American Geographers Annual Conference*, Seattle, WA, April 2011.
- Isaak, Marissa, *Playing Politics at the World Bank: The Red-Dead Canal*, March 2011.
- Isaak, Marissa, *Prospects for Desalination in Israel, American-Israel Cooperative Institute Conference*, Washington, DC, September 2011.
- Lien, Aaron, J.B. Nadeau, C. Rupprecht, and S.B. Megdal, “Water Efficiency: Environment or Growth?” Panel, *WaterSmart Innovations Conference*, Las Vegas, NV, October 2011.
- Megdal, Sharon B., *The Central Arizona Groundwater Replenishment District’s Role in Meeting the Renewable Water Supply Needs of Central Arizona, USDA Agricultural Research Service, Maricopa, AZ, January 2011.*
- Megdal, Sharon B., *Water, People and the Future: Challenges Associated with Meeting Competing Water Demands, Global Implications for Domestic and Industrial Water Reuse Workshop*, Tucson, AZ, January 2011.
- Megdal, Sharon B., *Water Sustainability Issues in Arizona, Rural Water Infrastructure Committee Arizona Water Infrastructure Finance Authority*, Tucson, AZ, February 2011.
- Megdal, Sharon B., *Arizona’s Water Future: Challenges and Opportunities, Arizona House of Representatives Committee on Agriculture and Water*, Phoenix, AZ, March 2011.
- Megdal, Sharon B., *The Energy-Water Nexus, Workshop on Water Security Challenges Emanating from the Intersections of Climate and Water Scarcity in the Arid Americas*, Los Cabos, Mexico, March 2011.
- Megdal, Sharon B., *International Energy, Water, Environment/Clean Technologies (EWE CT) Center R&D Projects/Initiatives Workshop, Royal Scientific Society supported by USAID Jordan Economic Development Program*, Amman, Jordan, March 2011.
- Megdal, Sharon B., *The Importance of Water for Arizona’s Future, San Xavier Kiwanis*, Tucson, AZ, March 2011.
- Megdal, Sharon B., *The Future of Arizona’s Built Environment: The role of the Design and Planning Professionals, College of Architecture and Landscape Architecture Seminar*, University of Arizona, Tucson, AZ, April 2011.
- Megdal, Sharon B., *Salinity and Desalination in the Southwest: Challenges and Solutions, Annual Conference of the Water Resources Research Center*, Yuma, AZ, April 2011.
- Megdal, Sharon B., *Uncertainty and Sustainable Water Management in Arizona, Flinn-Brown Civic Leadership Academy*, Phoenix, AZ, April 2011.
- Megdal, Sharon B., *Water Pricing and Public versus Private Water Company Ownership: Meeting Water Policy Goals, Environmental Law and Economics Seminar*, University of Arizona, Tucson, AZ, April 2011.
- Megdal, Sharon B., Joanna B. Nadeau, and B. Choate, *The Forgotten Sector: Defining and Securing Water for the Environment, WRRC Annual Conference*, Yuma, AZ, April 2011.
- Megdal, Sharon B., *Water and Sustainable Communities ULI Sustainable Development Council, National ULI Real Estate Summit: Adapting for the Future —Today*, Phoenix, AZ, May 2011.
- Megdal, Sharon B. and J.B. Nadeau, *Inspiring Water Conservation for Environmental Enhancement, American Water Works Association Annual Conference & Expo*, Washington, DC, June 2011.
- Megdal, Sharon B., *The State of the River: Understanding Supply and Demand, Navigating the Future of the Colorado River Conference*, University of Colorado Law School, Boulder, CO, June 2011.

Appendix

WRRC Presentations (alphabetical by presenter(s), chronological by date)

- Megdal, Sharon B., Update on the Arizona-Sonora Portion of the United States-Mexico Transboundary Aquifer Assessment Program, Water Committee of the Arizona-Sonora Commission, Litchfield Park, AZ, June, 2011.
- Megdal, Sharon B., J.B. Nadeau, and C.L. Rupprecht, *Walton Family Foundation Water Conservation Meeting*, Denver, CO, June 2011.
- Megdal, Sharon B., *Agricultural-Environmental Cooperation and Fact-Finding Field Trip to Oregon*, Participant and Project PI/Leader, August 2011.
- Megdal, Sharon B., CAP and Sustainability in the Tucson Region, *Southern Arizona Environmental Management Society Seminar*, Tucson, AZ, September 2011.
- Megdal, Sharon B., A. Lien, J.B. Nadeau, and C.L. Rupprecht, Conserve to Enhance - Tucson AZ Pilot Overview, *Metropolitan Water District of Southern California Water Use Efficiency Meeting*, Los Angeles, CA, September 2011.
- Megdal, Sharon B., Current and Emerging Policy Issues Relevant to Planning Professionals: Short Course on Planning for Water, *Arizona Planning Association State Conference*, Tucson, AZ, September 2011.
- Megdal, Sharon B., GEF Project on “Groundwater Governance: A Global Framework for Country Action,” *Inception Meeting*, UNESCO, Paris, France, September 2011.
- Megdal, Sharon B., Program on the Report of Regional Water Assessment Task Force “Think Tank” Process, Tucson, AZ, September 2011.
- Megdal, Sharon B., Uncertainty and Sustainable Water Management in Arizona, *Arizona Housing Forum*, Scottsdale, AZ, September 2011.
- Megdal, Sharon B., Arizona and Israeli Water Policy: Some Similarities and Differences, *Arizona Center for Judaic Studies Seminar*, University of Arizona, Tucson, AZ, October 2011.
- Megdal, Sharon B., Challenges to Sustainable Water Management in Arizona, *Institute of the Environment Honors Seminar*, University of Arizona Tucson, AZ, October 2011.
- Megdal, Sharon B., Institutional Assessment of the Transboundary Santa Cruz and San Pedro Aquifers on the United States-Mexico Border, *ISARM2010 International Conference on Transboundary Aquifers: Challenges and New Directions*, Paris, France, December 2011.
- Megdal, Sharon B., Integrated Transboundary Groundwater Management, Tools and Methods, *UNESCO Second Pilot Course*, Paris, France, December 2011.
- Megdal, Sharon B. and J.B. Nadeau, “Quantifying and Funding Water for the Environment: Researchers Assisting Practitioners,” *Universities Council on Water Resources (UCOWR)/National Institutes for Water Resources (NIWR) Annual Conference*, Boulder, CO, July 2011.
- Megdal, Sharon B., A. Lien, J.B. Nadeau, and C. Rupprecht, “Conserve to Enhance: Linking Water Conservation to the Environment,” *American Water Resources Association*, Albuquerque, NM, November 2011.
- Mott Lacroix, Kelly, Assessing Water Supply Vulnerability in a Water Scarce State: The Arizona Water Sustainability Evaluation, *International Water Resources Association 14th World Water Congress*, Porto de Galinhas, Brazil, September 2011.
- Mott Lacroix, Kelly, Arizona Water Management Along the Adaptive Cycle: What can the ebb of water governance teach us about future flows? Watersheds Near and Far, *Annual Meeting of the Arizona Hydrological Society*, Flagstaff, Arizona, September 2011.
- Nadeau, Joanna B., S.B. Megdal and B. Choate, The Forgotten Sector: Defining and Securing Water for the Environment (poster), *Navigating the Future of the Colorado River Conference*, University of Colorado Law School, Boulder, CO, June 2011.
- Nadeau, Joanna and S.B. Megdal, Quantifying and Funding Water for the Environment: Researchers Assisting Practitioners, *UCOWR/NIWR Annual Conference: Planning for Tomorrow's Water: Snowpack, Aquifers, and Reservoirs*, Boulder, CO, July 2011.
- Nadeau, Joanna B., S.B. Megdal, and C. Rupprecht, “Securing Water for the Environment,” *Water Resources Research Center (WRRC)*

Appendix

WRRC Presentations (alphabetical by presenter(s), chronological by date)

- Brown Bag*, Tucson, AZ, February 2011.
- Nadeau, Joanna B., C. Rupprecht, and S.B. Megdal, *Southern California Office, Bureau of Reclamation*, Temecula, CA, January 2011.
- Nadeau, Joanna B. and S.B. Megdal, *Water Resources Development Commission (WRDC) Environmental Condition Subcommittee*, Phoenix, AZ, January 2011.
- Nadeau, Joanna B., C. Rupprecht, and S.B. Megdal, *Tucson Pilot Program Participant Orientation*, Tucson, AZ, February 2011.
- Nadeau, Joanna B. and S.B. Megdal, *Conserve to Enhance, Roaring Fork Watershed Collaborative*, Carbondale, CO, April 2011.
- Nadeau, Joanna B. and S.B. Megdal, *Arizona Environmental Water Needs Assessment and Methodology Guidebook, The Instream Flow Council FLOW Conference*, Nashville, TN, May 2011.
- Nadeau, Joanna B. and S.B. Megdal, *Arizona Environmental Water Needs Assessment, Science on the Sonoita Plain*, Sonoita, AZ, June 2011.
- Nadeau, Joanna B., B. Choate, C.L. Rupprecht, and S.B. Megdal, *WRRC Brown Bag/C2E Listening Session*, Tucson, AZ, July 2011.
- Nadeau, Joanna B., K. Mott Lacroix, and S.B. Megdal, *Connecting the Environment to Arizona Water Planning, Stakeholder meeting*, Tucson, AZ, December 2011.
- Nadeau, Joanna B., K. Mott Lacroix, and S.B. Megdal, *Connecting the Environment to Arizona Water Planning, Stakeholder meeting*, Phoenix, AZ, December 2011.
- Prichard, Andrea, "Interbasin Water Transfers at the U.S.-Mexico Border City of Nogales, Sonora: Implications for Aquifers and Water Security," *UA Environmental Research Grad Blitz*, November 2011.
- Rupprecht, Candice, J.B. Nadeau, and S.B. Megdal, "Meeting the Challenge of Water for the Environment: Innovative Tools for Restoration Practitioners," *Arizona Riparian Council*, Yuma, AZ, March 2011.
- Rupprecht, Candice, J.B. Nadeau, and S.B. Megdal, *Tucson-Pima Metropolitan Energy Commission*, Tucson, AZ, June 2011.
- Rupprecht, Candice, J.B. Nadeau, and S.B. Megdal, *Cienega Watershed Partnership*, Tucson, AZ, July 2011.
- Rupprecht, Candice, E.M. Brott, A. Lien, S.B. Megdal, and J.B. Nadeau, *WaterSmart Innovations Conference*, Las Vegas, NV, October 2011.
- Rupprecht, Candice, J.B. Nadeau, A. Lien and S.B. Megdal, "Conserving Water for the Environment in Tucson, Arizona: A Pilot Program," *University of Arizona Cooperative Extension County Directors Meeting*, Phoenix, AZ, November 2011.
- Schwartz, Kerry and C.L. Rupprecht, *Water Resources in Tucson, Tohono Chul Docent Training Class*, Tucson, AZ, February 2011.
- Schwartz, Kerry and C.L. Rupprecht, *Arizona Project WET: Lessons that Bring Water Concepts in to the Classroom using 21st Century Learning Strategies, Tucson Water's Summer Internship Program for Teachers*, Tucson, AZ, July 2011.
- Schwartz, Kerry and C.L. Rupprecht, *STEM-focused Water Education for 4-6 Grade Teachers, Arizona Center for STEM Teachers Summer Institute*, Biosphere 2, Oracle, AZ, July 2011.
- Schwartz, Kerry, C.L. Rupprecht, and H. Thomas-Hillburn, *APW-FOSS Integrated 3rd Grade Water Unit, Tucson, Sunnyside and Flowing Wells Unified School Districts*, UA Environmental Research Laboratory, Tucson, AZ, January 2011.
- Schwartz, Kerry, C.L. Rupprecht, and H. Thomas-Hillburn, *Energy & Environmental Science 6th Grade Unit, Tucson, Sunnyside and Flowing Wells Unified School Districts*, UA Environmental Research Laboratory, Tucson, AZ, January 2011.
- Schwartz, Kerry, C.L. Rupprecht, and H. Thomas-Hillburn, *Pinal County Water Education Teacher Cohort Professional Development Workshop Series*, Pinal County, AZ, January and February 2011.
- Schwartz, Kerry, C.L. Rupprecht, and H. Thomas-Hillburn, *Americorps - 3rd Grade Groundwater Flow Model Training, Water Resources Research Center*, Tucson, AZ, February 2011.

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WRRC Presentations (alphabetical by presenter(s), chronological by date)

- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *Arizona Conserve Water*, Torreon Golf Club, Pinetop, AZ, February 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, Project-based learning with Arizona Project WET, *Monterey Park Learning Center*, Phoenix Elementary School District, Phoenix, AZ, February 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *School Water Audit Program Pinal County Teacher Cohort Professional Development Workshop Series*, Pinal County, AZ, February, July, and September 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, 21st Century Skill Development Using Arizona Project WET lessons, *RET G-K-12 Program*, University of Arizona, Tucson, AZ, March 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *Americorps - 6th Grade Groundwater Flow Model Training*, *Water Resources Research Center*, Tucson, AZ, March 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, The Colorado River Compact: History Informing the Present, *NAU Colloquium: Teaching American History through Historical Investigations*, Grand Canyon National Park, South Rim, AZ, April 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, Salinity and Desalination: Vehicles to Bring Concepts in to the Classroom, *Water Resources Research Center Annual Conference*, Yuma, AZ, April 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, Water Investigations Program Symposium: Middle School Students Present Results of their Scientific Investigations, *Facilitated Colloquia*, UA Student Union, Tucson, AZ, April 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *NASA Earth Camp for Teachers Professional Development Workshop Series*, Environmental Research Laboratory and Sonora Desert Museum, April, May, and June 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, Energy and Environmental Science 6th Grade Curriculum Unit Revision: Improving the Energy Component, *Facilitated Colloquia*, Tucson Unified School District, Tucson, AZ, May 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, School Water Audit Program (SWAP) Symposium: Middle School Students Present Results of their School Water Audit, *Facilitated Colloquia*, University of Arizona, Tucson, AZ, May 2011.
- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *An Advanced Water Education Workshop: Water and Public Perception*, ASU Decision Center for a Desert City, Tempe, AZ, June 2011.
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- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, Energy & Environmental Science 6th Grade Unit, *Tucson, Sunnyside and Flowing Wells Unified School Districts*, UA Environmental Research Laboratory, Tucson, AZ, June 2011.
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- Schwartz, Kerry, C. Rupprecht, and H. Thomas-Hillburn, *Water Investigations Program Professional Development Workshop Series*, Hassayampa River Preserve, 91st Avenue Wastewater Treatment Plant and Maricopa County Cooperative Extension Office, Phoenix, AZ, July 2011.
- Scott, Christopher and S.B. Megdal, The Challenge of Binational Decision-Making in Arizona-Sonora Transboundary Watersheds, *UCOWR/NIWR Annual Conference Planning for Tomorrow's Water: Snowpack, Aquifers, and Reservoirs*, Boulder, CO, July 2011.



ARIZONA WATER

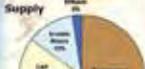
COLORADO RIVER BASIN



WATERSHEDS



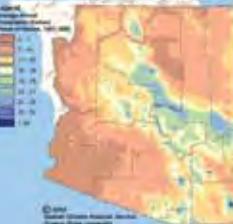
WATER SUPPLY AND DEMAND



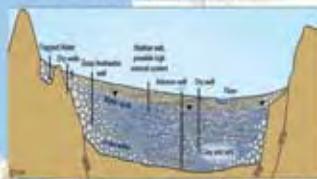
Total Volume: 7,216,000 Acre-Foot



ANNUAL PRECIPITATION



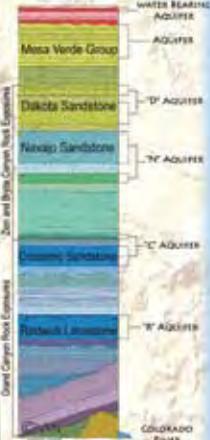
BASIN AND RANGE ALLUVIAL AQUIFERS



GROUNDWATER BASINS



COLORADO PLATEAU AQUIFERS



PHYSIOGRAPHIC PROVINCES



WATER QUALITY



Comparison of pollutants in Arizona's impaired lakes and streams. Source: Water Quality Assessment (WQA) Report, 2002. WQA is a required component of the Clean Water Act (CWA).



Water Resources Research Center
College of Agriculture and Life Sciences
The University of Arizona
Tucson, Arizona 85721
www.wrrc.arizona.edu



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Research, Extension & Education for Real World Issues



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wrrc.arizona.edu

350 N Campbell Ave. • Tucson, AZ 85721 • (520) 621-9591