THE AQUAHOMAN

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The newsletter of the
OKLAHOMA WATER RESOURCES CENTER

Inside this issue:

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Dr. Kevin Wagner

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Leslie Elmore

Oklahoma Water Resources Center

From the Director's Desk (by Kevin Wagner)

Last month, I had the opportunity to meet with water center directors from across the U.S. at the 2018 National Institutes for Water Resources Annual Meeting in Washington, DC. This is always a great meeting to learn about activities and successes of other water centers around the nation (also created by the Water Resources Research Act). It was interesting to see how research priorities differ across the U.S., from coastal flooding in the Northeast to harmful algal blooms in the Midwest to agricultural water use and environmental flows in the West. These discussions really highlighted the need and opportunities for collaboration to address regional and national issues.

As part of our meeting, we were also able to visit with Oklahoma's Congressional delegation, as well as key water research partners such as the USGS, EPA, USDA, and NSF.

Oklahoma's Congressional delegation is aware of major water issues and supportive of efforts to solve them.

Senator James Lankford and Dr. Kevin Wagner

In visiting with agency partners, a common theme was the importance of developing the next generation of water resource professionals. Specific research interests were also discussed by the agencies.

For the USGS National Water Quality Program, research priorities included:

- harmful algal blooms
- water availability
- sediment
- ecological flows
- human and ecosystem health outcomes
- groundwater/surface water interactions
- forecasting water quality

Additionally, the USGS Water Availability and Use Science Program was interested in:

- development of 3-D/4-D models for characterizing the hydrologic cycle
- linking human water use and the hydrologic cycle
- advancing ecological flow science
- conducting integrated watershed assessment research

EPA was working to advance:

- monitoring techniques for pathogens, nutrients, and harmful algal blooms
- stormwater management
- water treatment and infrastructure

The USDA National Institute for Food and Agriculture will be focusing on improving agricultural system sustainability. They have again partnered with NSF to support research on the food-energy-water nexus.

With so many research foci, there are certainly many exciting opportunities for working with fellow water centers and these agencies to advance water research needed to solve state, regional and national water issues. This is a primary role water centers serve in each state. I look forward to working you to help secure Oklahoma's water future.

Oklahoma Department of Agriculture, Food and Forestry

(by Jeremy L. Seiger, Environmental Programs Director)

About ODAFF

Historically, Oklahoma agriculture has meant cattle and wheat to most people, and justifiably so. According to the latest agriculture data, Oklahoma is the third largest beef cattle producing state in the nation, the third largest producer of wheat, and is fourth in the nation for number of farms (78,100). However, Oklahoma agriculture in the 21st century is much more than beef and wheat.

Crops and livestock that were once relatively small in terms of production have grown dramatically in recent years. For example, swine and poultry, respectively, are Oklahoma's second and third largest agricultural industries, and Oklahoma is now one of the top states in swine and poultry production. The following statistics are truly remarkable for a state the size of Oklahoma!

- Oklahoma has nearly $8 billion of raw ag products grown in the state every year.
- Oklahoma agriculture contributes roughly $42.5 billion in direct economic impact and $18.2 billion in indirect impact to our state's economy.
- Oklahoma has over 34,000,000 acres in agriculture production.
- The agricultural industry provides jobs for over 321,000 Oklahomans.
- Agriculture is the only industry nationwide that has had a trade surplus for the last 50 years.

To assist in the success of Oklahoma agriculture, the Oklahoma Department of Agriculture, Food, and Forestry (ODAFF), is comprised of several divisions that serve distinct roles to protect and educate consumers about Oklahoma's agricultural and livestock productions. ***ODAFF divisions work to meet the needs of Oklahoma's farmers and ranchers, promote agricultural trade and production, work to assure food safety, protect natural resources, and foster rural communities.***

About the AEMS Division

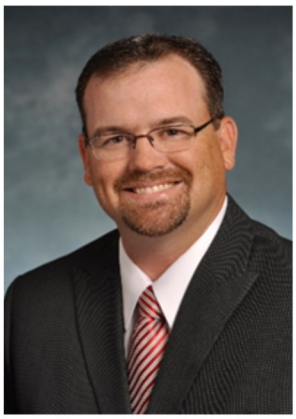
In 1997, the Oklahoma Department of Agriculture and the Oklahoma State Legislature recognized the need for a division dedicated to protecting the state's soils and waters from animal manure and other waste products. As a result, on July 1, 1997 the Water Quality Services Division was created, and on July 1, 2004 the Division was renamed as the Agricultural Environmental Management Services (AEMS). The AEMS Division was created to help develop, coordinate and oversee environmental policies and programs and to provide protection for the waters of Oklahoma from agriculture operations, while maintaining environment compatibility with agriculture production. Among the division's primary responsibilities is the licensing and inspecting of Concentrated Animal Feeding Operations, Poultry Feeding Operations, Poultry Waste Applicators, agriculture compost facilities, and addressing citizen complaints.

About Me

I had the opportunity to join the ODAFF family in 2013 as the AEMS hydrologist; in March 2014 I was appointed to Director of the Division. Since that time, I have really enjoyed working with the ODAFF family while working to foster good relationships with folks from other state agencies and organizations.

Prior to returning to my home state of Oklahoma, I worked at the Environmental Protection Agency (EPA) Region 6 office in Dallas, TX. During my ten years at EPA, I worked in Dallas, Washington D.C., and the EPA Office of Research and Development laboratory in Ada. I am an alumnus of the Texas Agricultural Lifetime Leadership program, which allowed me the opportunity to observe different agricultural practices and legislative processes in Texas, Washington D.C., New York, California, and Brazil.

A native of Hennessey, Oklahoma, I earned a Bachelor of Science and a Master of Science degree in Plant and Soil Sciences, with a minor in Geology from Oklahoma State University. My wife and I, along with our two children live in the small community of Newalla.



Jeremy Seiger, Director, Agricultural Environmental Management Services Division, ODAFF

Produced Water: Contaminant Reduction through Algal Biomass Production

(by Brittany Davis, Water Center staff writer)

Dr. Nurhan Dunford, a professor of Biosystems and Agricultural Engineering at Oklahoma State, recently completed research on *Algal Remediation of Wastewater Produced during Hydraulic Fracturing*. Her research, supported by the Oklahoma Water Resources Center with funding from the USGS 104(b) grant program, examined microorganisms' potential to reduce contaminant concentration in water produced during the hydraulic fracturing process for natural gas and oil extraction (i.e., produced water).

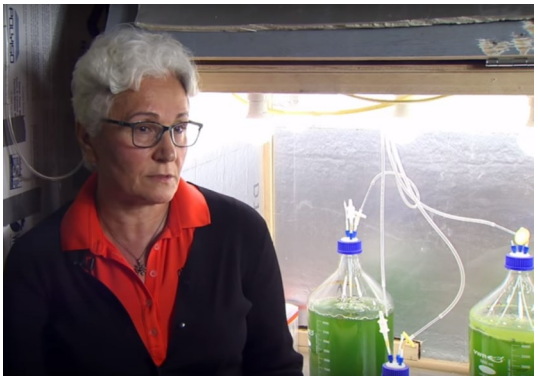
There are limited ways to dispose of the large volumes of produced water generated by the oil and gas industry. Among these methods, many are expensive and could impact groundwater sources. As Oklahoma is heavily involved in the oil and gas industry, the invention of new practices for wastewater reuse and remediation is integral to the continued success of the industry in the state, as well as the sustained well-being of remaining water sources.

According to Dunford, "microalgae provide a viable solution to the problem of environmental pollution." When the microorganisms are grown, they not only clean wastewater, but they provide feedstock for renewable fuels, and other bio-based products. In fact, this was the aspect of the project that most interested Dr. Dunford. As a researcher heavily involved in biofuels and bioproduct development, she saw this project as ***a way to use an abundant "waste" resource (i.e., produced water) to create desirable next-generation bioproducts.***

Dunford's research began by determining what nutrients and contaminants were present in produced water and identifying Oklahoma-native algae strains capable of growing in produced water. Water from nine different wells producing flowback and produced water at different locations in Oklahoma were monitored for water quality parameters including conductivity, pH, boron, nitrogen, aluminum and other metal content, chemical oxygen demand, biological oxygen demand, and additional parameters.

Over twenty different microalgae strains were evaluated to determine the strain best suited for reducing contaminant levels and producing biomass in standard growth media. The best performing strains were then cultivated in the flowback and produced water samples. Once algae cells reached their stationary growth phase, the wastewater was separated from the algal biomass and tested to assess contaminant reductions.

Produced water has naturally low nutrient concentrations, particularly nitrogen and phosphorous needed for algae growth. Dunford and her team tested the effect of nutrient concentration on biomass production and contaminant removal by growing algae in three different media with varying levels of nutrients. The media included original produced water, nutrient supplemented produced water, and industry standard media. Dunford found that algae's reduction of contaminants is most efficient when produced water was supplemented with nutrients. The research found that the addition of these two nutrients to produced water samples generated a steep increase in algal biomass growth and consequently, more contaminants were removed.



Dr. Nurhan Dunford in her laboratory.

Dunford was pleasantly surprised to find out how efficiently native Oklahoma algae strains removed contaminants from produced water. "We have not only demonstrated that many of the Oklahoma-native algae strains grow in both produced and flowback water, but, they also remove about 80-90% of the boron and significantly reduce many other contaminants present in wastewater."

While Dunford's research was notably successful, she affirms additional research using larger produced water treatment tests to be carried out in outdoor open algae growth ponds, and downstream processing of the algae treated produced water could help us to understand how to best optimize the remediation process.

Learn more about Dr. Dunford's project at http://water.okstate.edu/library/reports/project-reports/2016-projects. Be sure to read our "Faculty Spotlight" on Dr. Dunford on the next page.

Faculty Spotlight: Nurhan Dunford

(by Dr. Nurhan Dunford, a professor of Biosystems and Agricultural Engineering, Oklahoma State University)

Dr. Nurhan Dunford in Urla, Turkey.

I am a professor in Biosystems and Agricultural Engineering Department and the oil and oilseed specialist at Robert M. Kerr Food and Agricultural Products Center at Oklahoma State University (OSU). I am involved in all 3 land grand missions of the university: teaching, research and extension. I came to OSU about 18 years ago after a long career as an engineer and scientist in industry and federal government research institutes in Turkey, Canada, and the U.S.

Partly because of those experiences, my current research is very applied. I am very interested in systems design and process development and optimization for value-added product manufacturing. I choose my research topics from problems and issues facing production industry in the state. I am very concerned about the environmental sustainability, so our research tries to minimize the impact of processing on the environment. Our microalgae research* is an excellent example of what we are trying to do in my research group. Currently, our focus is on growing algae in animal wastewater and wastewater generated during hydraulic fracturing. My goal is to design and optimize a system that will produce algal biomass while cleaning up wastewater. Treated wastewater can be used for irrigation or in industrial applications, and algal biomass can be converted to renewable products, including biofuels.

On the personal side, I love research and I am passionate about scholar development—training undergraduate and graduate students and young scientists. Over the years, I have worked with students, technicians and scientists from the U.S., Austria, Australia, Sweden, Indonesia, China, India, Iraq, Iran, Italy, Turkey, Mexico, Columbia, Canada, Philippines, Denmark, Romania, Bulgaria, Poland, and South Korea. I have immensely enjoyed my experiences with them and found the opportunity rewarding.

I love reading non-fiction books, listening to music, swimming, downhill skiing, and traveling. The last book I read was “Killers of the Flower Moon” by David Grann. Currently I am reading “Sundown” by John Joseph Mathews. Both books are about Osage Native Indians in Oklahoma and what happened to them during 1920s. I am fascinated by these stories and plan on visiting Pawhuska, Oklahoma at the first opportunity I get.

*Be sure to read Dr. Dunford’s *Produced Water: Contaminant Reduction through Algal Biomass Production (pg* 3).

Ogallala Aquifer Summit | Garden City, KS | 4/9-10

This Summit, themed "Cultivating Cross-state Conversation & Collaboration” will bring together key stakeholders on water use to discuss current and developing management and policy best practices and how hurdles limiting wider adoption of efficient, practical, and profitable water use strategies might be overcome. Registration ($60) must be completed in advance.

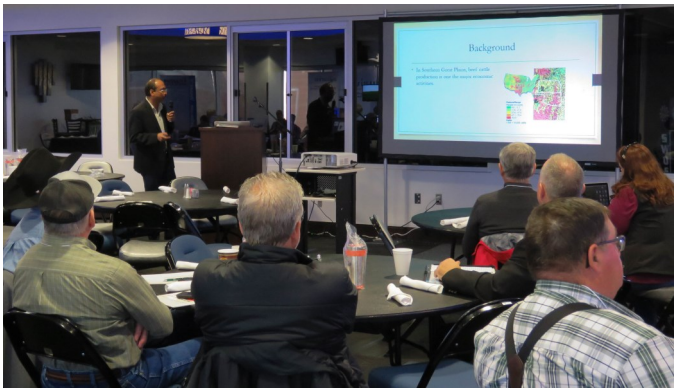
OgallalaWater.org

Oklahoma Irrigation Conference 2018 Recap

(by Saleh Taghvaeian, Assistant Professor and Kevin Wagner, Water Center Director)

The 2018 Oklahoma Irrigation Conference was held in Weatherford, OK on March 8. The event, which drew 58 agricultural producers, researchers, Extension educators, and suppliers, was hosted by the Oklahoma Cooperative Extension Service and the Oklahoma Water Resources Center. The conference provided them with the latest research-based insights and information on many irrigation-related subjects. Some of the research findings are briefly described below.

- ***Early-season deficit irrigation benefits*** corn and sorghum root development, resulting in more extensive root development during this early-stage and improving their ability to satisfy water demands during the critically important peak of the growing season
- ***No-till farming reduces wheat water use*** for both graze out and graze-grain options, especially during the fallow part of the year for wheat-canola production systems, wheat water use was larger under conventional tillage compared to no-till
- ***Reduced tillage*** increases watermelon sugar content. Additionally, ***uniform irrigation application is important*** for improving watermelon yield and quality.
- The ***Mesonet network is a great tool*** for tracking crop water use (i.e. evapotranspiration) and planning irrigation applications.
- ***Chemigation*** (i.e. applying fertilizers and pesticides in/with irrigation water) ***is a beneficial practice*** but safety measures must be applied (e.g. preventing leaks, runoff, and flow of chemicals back to the water source) and the system must be properly maintained to ensure chemicals are applied effectively and uniformly across the field.



Dr. Prasanna Gowda presents at the 2018 OK Irrigation Conference.

- ***Improving irrigation pumping plant efficiency to meet industry standards*** would reduce energy costs by about 30% for electric motors and 47% for natural gas engines.
- A range of ***beneficial services are offered by the OSU Soil, Water and Forage Analytical Laboratory*** including irrigation water quality and soil analyses.
- ***Irrigation water quality and application timing are important considerations.*** Peanuts, for instance, are sensitive to salinity. They are also sensitive to water stress during the pegging and nut development stages, thus proper irrigation timing is critical.
- ***A new web-based tool is available for optimizing irrigation scheduling on cotton*** — Dashboard for Irrigation Efficiency Management (DIEM).
- ***Sensor-based technologies can improve water applications*** by identifying soil moisture thus reducing potential under- or over-irrigation.

Southern Great Plains agricultural producers interested in hearing the latest research and visiting with other producers and sharing experiences may start planning to attend the next Irrigation Conference, tentatively scheduled for March 2019 in Guymon, OK.

2018 AWRC Annual Water Research Conference | July 23-24, 2018

"The Value of Water" is the theme for this year's conference, which will address the relationships between water supplies and industry. This conference brings in professionals and students not only from Arkansas, but from surrounding states as well. The call for proposals for presentations from professionals and students from all water resources is open through April 11, 2018. Details at https://arkansas-water-center.uark.edu/annual-conferences.php.

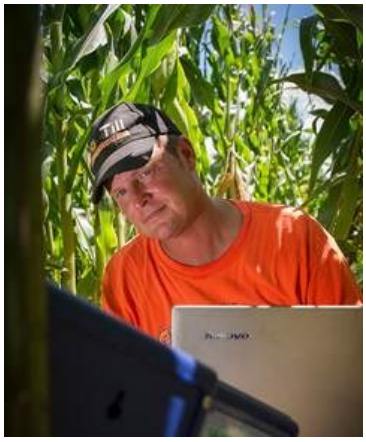
On-farm Sub-surface Drip Irrigation: How Does Soil Type Impact Efficiency and Management

(by Dr. Jason Warren, Associate Professor and Extension Specialist, Department of Plant and Soil Sciences)

Problem and Research Objectives:

Prior to this project there was a lack of understanding of how water moves in the soil away from subsurface drip irrigation. We generally expect that water will drain more rapidly in sandy soil with limited capillary movement to the surface from the drip tape. In contrast, drainage will be slower in clayey soils with more significant capillary movement to the surface making irrigation more effective. However, there is uncertainty about how irrigation strategy effects water movement in the soil. For example, given the flexibility of management for subsurface drip irrigation we can irrigate for a set number of concurrent hours every day or every other day or every third day and so on, with each of these strategies providing the same total amount of water distributed in time differently. It's hypothesized that larger less frequent irrigation events might increase the amount of water lost to drainage because of saturated conditions that would occur during the longer irrigation event. However, daily irrigation events do not allow for early season near surface soil drying which might limit root development.

In an effort to understand which strategy might be optimum, an on-farm project was initiated in the summer of 2016 with 2 objectives. The first objective was to better understand how producers apply water through their drip irrigation systems as well as why they choose the strategy used. The second objective was to evaluate soil water movement in a variety of production environments using subsurface drip irrigation.



Dr. Jason Warren downloads data from soil moisture data loggers..

Importance of Project and Findings:

The findings of this project will help to advance the efficient use of sub-surface drip irrigation in the Southern Plains. This technology is very new and there is a great need for information to understand how to optimize water use efficiency through improved irrigation strategies. As mentioned, there are many ideas and opinions on how to most effectively apply water through SDI, as well as many reasons why producers use the strategies they select. However, this project provides the needed data to evaluate the actual outcome of those decisions and will provide guidance for future improvements.

Principal Findings and Significance:

This project provided a wealth of preliminary data needed to improve our understanding of how SDI is being used in Oklahoma as well as how water moves in soils. We realized that the source of irrigation water plays an important role in how water is applied. Specifically, SDI in the Lugart-Altus irrigation district is designed with large zones capable of applying thousands of gallons per minute. In contrast, the systems utilizing ground water are designed to apply hundreds of gallons per minute. Also, in the Lugart-Altus district they have less flexibility in managing the water. Specifically, when produces order water, they must use it despite any change in the need for water resulting from rainfall or reductions in evapotranspiration.

The two producers in the Lugart-Altus district applied water daily in continuous 8-hour applications because of the expectation that this would most effectively optimize the surface soil moisture. In contrast, the producer in the Oklahoma Panhandle applied water on a 3-day rotation with 12-hour continuous applications because it matched his historic strategy of pivot irrigation. Unfortunately each of these soils were clay loams with similar hydrologic properties; therefore, we were not able to evaluate the impact of soil type on water movement.

The data collected in 2016 suggested the producer who used a 3-day irrigation rotation was more effective at maintaining surface soil moisture without saturating the subsoil. However, the on-farm approach was not capable of properly determining the validity of this observation; therefore, as mentioned, a side-by-side comparison of irrigation strategies for corn and grain sorghum was initiated in 2017.

In the summer of 2017, preliminary data collected supports the fact that ***less frequent yet larger irrigation events allow for more effective use of subsoil moisture***. This is believed to occur due to improved rooting depth, stimulated by periodic drying of the surface soil, which causes roots to grow into the wetter subsoil. This is a critical advantage for two reasons. First it allows the crop to use water captured and stored in the subsoil during the fallow period. Secondly, if irrigation capacity is not sufficient to replace daily evapotranspiration during the peak of the growing season, this subsoil moisture acts as a secondary water source, providing for more successful crop production. Crop yield, yet to be collected, is needed to confirm these assertions; however, visual observation of crop health support them.

Learn more about this project and the Berry Fellows Program at http://water.okstate.edu/researchers/berry-fellows-program.

Wheat Producers Facing Tough Call on Nitrogen Application

(by Leilana McKindra, Communications Specialist, Agricultural Communications Services)

Even after recent rains, Oklahoma wheat producers managing their crops for yield and grain quality are facing tough decisions about if, when and how much to fertilize at this critical juncture of the growing season.

The good news is producers still have time to act. However, in the wake of an extremely dry fall and winter and the window for fertilizing quickly closing, Oklahoma State University Cooperative Extension experts see three different scenarios taking shape.

In cases where there is good plant stand overall, producers should evaluate the crop's current yield potential and apply enough nitrogen to achieve it.

"With the rain and some sunshine, these plants will start growing again. For producers who use N-rich strips, if your field needs nitrogen, it should show up," said Brian Arnall, OSU Cooperative Extension precision nutrient management specialist.

Under a second scenario that could play out principally in southwest Oklahoma, some fields may be experiencing uneven growth, with a combination of already established wheat and wheat that has only started germinating and emerging with the most recent rains.

Producers may have a lot of questions about what to do under such circumstances, said David Marburger, OSU Cooperative Extension small grains specialist.

For example, if producers decide to keep the crop, will the newly emerging plants still have enough exposure to cooler temperatures to switch from vegetative growth to reproductive growth, and if so, what is the crop's yield potential overall?

"This is where it gets complicated, when we bring it back to the question of nitrogen management," Marburger said. "This is going to come down to producers closely assessing their stands and the yield potential of their crop. I think in most cases those newly emerging plants will switch to reproductive growth and put on a head. However, those plants will be delayed in their development, and the amount of grain produced by those heads will likely not be close to full potential."

When assessing a field's grain yield potential, a general rule of thumb is 60 to 70 tillers per square foot are needed to maximize yield. Dryland production in southwest Oklahoma and the Panhandle can lower that number to 50 to 60 tillers per square foot.

"If you have half or less, that's not a positive sign for taking the crop to grain. If you're a cattle producer just wanting to graze-out, that may be enough for you to keep the stand," Marburger said. "It comes back to your objective. If you decide to keep the stand in this case and apply nitrogen, consider lowering the rate from your normal application."

Meanwhile, a third scenario is emerging in far northwest Oklahoma into the Panhandle, where it has not rained and plants coming out of winter dormancy will begin growing.

"If there's no water there for those plants, they're going to quickly go backward and eventually die," Arnall said. "Producers should have their N-rich strips down in case it does rain soon, but most are likely hesitant to spend money to apply nitrogen to their fields if there's little to no yield potential."

For more information on wheat crop management strategies, contact the nearest county Extension office, visit www.wheat.okstate.edu and download free OSU Fact Sheets on the topic, including PSS-2149, "Estimating Wheat Grain Yield Potential," and AGEC-241, "Wheat Grazeout versus Harvest for Grain," at facts.okstate.edu.

For Oklahoma wheat producers who use N-rich strips, if their fields currently need nitrogen, it should show up. Producers can use GreenSeeker technology to determine the nutrient needs of their crops.

For more information on how proper nutrient application protects water quality, please visit our *Waste & Nutrient Management* page at http://water.okstate.edu/strengths/water-quality/waste-and-nutrient-management.

New & Noteworthy

Events (water.okstate.edu)

- OCLWA Annual Conference (Stillwater; 4/4-5)
- Ogallala Aquifer Summit (Garden City, KS; 4/9-10)
- Produced Water: Past, Present & a Look to the Future with Shellie Chard (webinar, 4/11)
- Dr. Jonathan Shurin presents "Climate and control of mountain lake food webs (Stillwater; 4/20)
- Southwest Stream & Wetland Restoration Conference (San Antonio, TX; 5/30-6/1)
- 2018 UCOWR/NIWR Annual Water Resources Conference (Pittsburgh, PN; 6/26-28)
- 2018 AWRC Annual Water Research Conference (Fayetteville, AR; 7/23-24)
- Ecological Society of America Annual Meeting (New Orleans, LA; 8/5-10)
- 2018 Early Career Researcher Professional Development Training (Baton Rouge, LA; 8/5-10)
- Global Water Security for Agriculture and Natural Resources (Taj Krishna, Hyderabad, India; 10/3-6)

Funding (http://water.okstate.edu/researchers/funding)

- EPA: Environmental Education Local Grants Program for Region 6 (due 4/11/18)
- NASA WR ROSES18 Solicitation (NOI due April 17)
- Foundation for Food and Agriculture Research: Seeding Solutions (pre-proposals due 4/18/18)
- NOAA: FY 2018 Remote Sensing for Snowpack and Soil Moisture (due 4/26/18)
- Bureau of Reclamation Desalination and Water Purification Research Program (due 5/1)
- Fish and Wildlife Service: 2018 National Fish Habitat Action Plan (due 5/31/18)
- NSF/USDA: INFEWS (due 9/26/18)

Job Board (http://water.okstate.edu/job-board)

- EPA: Environmental and Water Resource Support position

Connect

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