TEXAS WATER RESOURCES INSTITUTE

twri New Waves

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Meeting Water Quality Standards in Buck Creek

by Jenna Smith

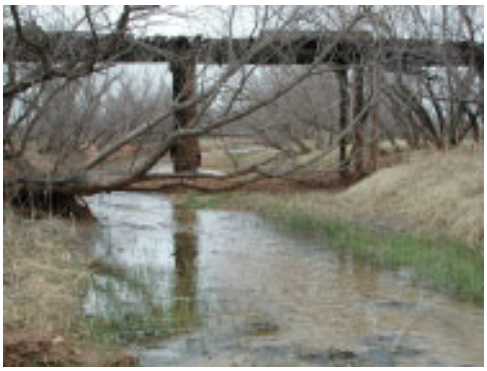

Photo courtesy of John Sij

Originating from saltwater seeps and springs in the Texas Panhandle, beautiful Buck Creek flows through Donley, Childress, and Collingsworth counties in the Red River Basin of Texas. Buck Creek is a subwatershed of the Lower Prairie Dog Town Fork of the Red River. The watershed is almost exclusively comprised of agricultural cropland and native grasslands.

"We want Buck Creek to be a healthy ecosystem suitable for fishing, wading, and other recreational activities," said John Sij, professor of agronomy at the Texas A&M Agricultural Research and Extension Center at Vernon. However, water quality testing in the late 1990's found bacteria levels were sometimes elevated in the Creek. By testing for the presence of indicator organisms such as fecal coliform bacteria and *E. coli,* scientists at the Vernon Research and Extension Center can monitor whether these indicator organisms are at high enough levels to indicate the potential presence of disease-causing pathogens, which pose a threat to public health.

Buck Creek is considered an impaired water body according to section 303(d) of the Clean Water Act. Therefore, a total maximum daily load (TMDL) for each pollutant contributing to the impairment within the Creek is being developed. TMDLs are created to determine the maximum amount of a pollutant that a water body can receive and still maintain its beneficial uses.

"The ultimate goal of this TMDL is the reduction of indicator bacteria to levels that constitute an acceptable level for recreational exposure," said Sij. "This allows recreational activities to be restored to the water body."

Thirteen sampling sites have been implemented along Buck Creek to collect water samples to test for these indicator organisms. Samples are collected every two weeks at sites where running water is present. Sampling will also be conducted following high rainfall events, when potentially large numbers of fecal bacteria enter the Creek from stormwater runoff.

"The impairment within the water body is due to nonpoint sources, perhaps from livestock production and/or wildlife," said Sij. "By identifying the source and minimizing the input of fecal material into Buck Creek, we can maintain the water body within water quality standards."

Bacterial monitoring will be conducted on a flow-based approach, using frequency distributions over a historical range of flows rather than a single target concentration. This method can greatly enhance assessment and load reduction practices within the waterbody.

By using a 65 percent reduction mean criteria, bacterial loadings would be reduced enough to comply with existing water quality standards and restore recreational uses in the Creek.

"The key to restoring Buck Creek is targeting impairment sources and implementing preventative measures," said Sij. "Educating area stakeholders will help ensure a viable recreational resource for the future."

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make every drop count

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THE TEXAS A&M UNIVERSITY SYSTEM

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The Texas A&M University System

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TEXAS GROUND WATER 2004

Towards Sustainability

NOV. 18-19
AUSTIN, TEXAS
Texas State Capitol Extension

The concern for Texas' groundwater supplies has caused our state legislature to consider making significant changes in groundwater law. As a Texan, it is important for you to understand the potential new laws surrounding this viable water source in our state. As a service to you, a 3-day groundwater conference entitled **Texas Groundwater 2004 will be held November 17-19, 2004, at the Texas State Capitol Extension in Austin, Texas**. Important state leaders will be on hand to provide information and feedback to participants on our proposed new groundwater policy.

The conference will address such issues as the following:

- Texas aquifer science
- Groundwater technology
- State policy issues

In addition, the conference will offer roundtable discussions on current water research, provide exhibits for participants, hold a poster contest for students, and offer continuing education courses in groundwater management techniques.

For more information on conference events, visit www.txstate.edu/iiswr.

Subsurface Drip Irrigation Reaching New Depths

by Kellie Potucek

A growing number of ranches bordering urban cities in Texas are being sold off as suburbanized "ranchettes," and new owners are asking how they can maximize the use of their land. Many owners desire to raise livestock for 4-H or recreational purposes, but do not have the time or labor to manage grazing land with conventional sprinkler irrigation. Dr. David Forbes of the Texas Agricultural Experiment Station in Uvalde is investigating subsurface drip irrigation as an economically feasible alternative.

In subsurface drip irrigation, plants are directly watered at their root zone via buried hoses referred to as *drip lines*. Drip lines are laid approximately nine inches below the soil surface and precisely distribute water flow. Water is supplied from a central source and serviced by a filtration facility in the system that can also inject fertilizers and pesticides. The technology is traditionally used by crop farmers, but is more recently being adopted for other applications.

During the 2002 season, Forbes installed a subsurface drip irrigation system on a two acre plot and established vegetation using rooted transplants of Tifton 85 bermudagrass. The two acres were subdivided into eight 0.25 acre plots. Based on calculations supplied by the Uvalde Center weather station, Forbes irrigated half of the plots at 25 percent potential evapotranspiration (PET) and the other half at 50 percent PET. "Of the four plots receiving each irrigation treatment, half were designated for hay production and the other two designated for grazing," explained Forbes.

When comparing outputs from subsurface drip irrigation and sprinkler irrigation, Forbes says his research, though not yet complete, clearly suggests subsurface drip irrigation is a viable method in sustaining a forage-livestock system. He explained the most significant advantage of subsurface drip irrigation is that it completely eliminates evaporative loss, which conserves water and saves money.

Subsurface drip irrigation also has several other benefits over sprinkler irrigation. For example, the system is very successful in atypically shaped areas that are not adequately watered by sprinklers. Farmers value this feature because they can install a system in the corners of their crop fields that are often missed by conventional sprinklers. Because the quality of drip tape has greatly improved, systems have an average life of 10 to 12 years and do not suffer from corrosion as do traditional pipes. Additionally, because there are no sprinkler heads exposed, the system is more aesthetically pleasing and is less prone to vandalism and theft. Home owners and athletic complexes are increasingly adopting the submerged technology for these reasons.

Forbes said, currently, the main obstacle in subsurface drip irrigation is finding someone to install the system. However, once installed, maintenance is relatively simple, but essential. The system has a filter that must be checked at least twice a year, and acids should be injected to clean the lines. Some users have reported fire ant damage to the drip lines, but pesticide application may solve the problem.

Forbes was awarded two Soil and Water Conservation grants from Texas Water Resources Institute in previous years and will continue his research with funds awarded by the Texas Water Development Board.

Dairy Manure Compost in Action

by Jenna Smith

Counties throughout the Bosque and Leon River Watersheds have a first-hand opportunity to view the benefits of dairy manure compost. By utilizing nutrient-rich dairy compost on lawns and athletic fields, county residents have learned that using compost as a soil amendment is a viable alternative to traditional inputs and benefits their local environment as well.

Compost, a dark, organically rich material that has been used for decades, serves as a soil amendment and as a nutrient source for plants. It can be applied as a mulch layer to reduce evaporation, or incorporated into the soil to increase soil organic matter, which improves soil structure and water-holding capacity. Compost also improves the chemical character of the soil by buffering soil pH (preventing rapid pH changes) and serving as a source of essential plant nutrients including nitrogen, phosphorus and potassium. Since most soils are deficient in organic matter, just about any soil type will benefit from the addition of compost.

Photo courtesy of Scott Mauney

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Compost

continued from page 3

Through a project funded by the Texas Commission on Environmental Quality and the Environmental Protection Agency, personnel with Texas Cooperative Extension and Texas Water Resources Institute have assisted dairy manure composters in increasing market potential for composted dairy manure in and around the Bosque and Leon River Watersheds.

"While there is an abundant source of dairy manure compost within the Watershed, the industry lacks adequate information on the correct use and marketing ability of the product," said Cecilia Gerngross, program specialist for Texas Cooperative Extension and Texas Water Resources Institute. "Because there is so much compost within a concentrated area, it is imperative to improve compost consistency and focus on a variety of markets."

In establishing these various markets, several county demonstrations were developed to verify existing and evaluate new uses of dairy manure compost in the Watershed. Extension agents within each participating county evaluated the effects of the compost while providing an alternative outlet for dairy manure at the same time, decreasing the amount of phosphorus potentially released into the Watershed. Phosphorus is an important plant nutrient, but in excess can pose a threat to water quality in streams, rivers and lakes. By utilizing dairy manure to produce compost for application off the farm, both dairies and compost users benefit.

In Palo Pinto County, Santo ISD worked with County Extension Agent, Scott Mauney, to top-dress and aerify their football playing field. Prior to the dairy compost application, school officials were concerned the thin stand of turf could potentially cause injury to athletes. Compost and supplemental inorganic nitrogen were applied to the field and within one month following the application, turf grass density across the field increased and grass texture was softer than in years before. Additionally, Santo ISD participated in the Composted Manure Incentive Program, sponsored by Texas Commission on Environmental Quality, which provided the school district with a rebate of $5 per cubic yard of dairy compost purchased.

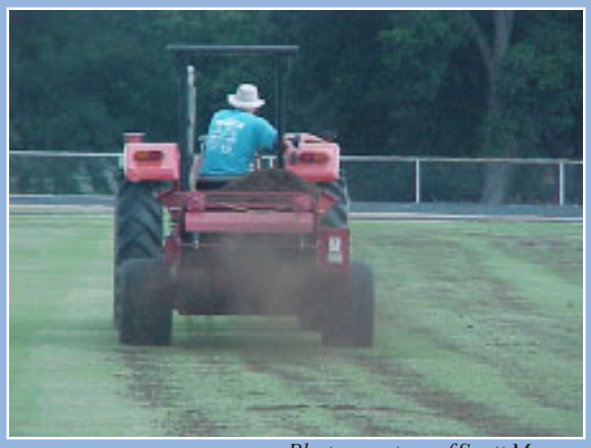

Photo courtesy of Scott Mauney

Photo courtesy of Jason McAlister

Similar demonstrations have also been established in Comanche, Coryell, Erath, Somervell, Stephens and Tarrant counties at such locations as athletic fields, county courthouses and city parks. "Public entities, such as school districts, cities or state agencies can all utilize dairy manure compost in their environmental management plans as it can be used to provide nutrients and organic matter and control erosion," said Gerngross. "These nutrients and organic matter can also be used in revegetation efforts like those occurring on training areas at Fort Hood."

According to Bill Fox, senior research scientist and project manager for the Rangeland Revegetation Pilot Project Federal Initiative through the Texas Water Resources Institute, the use of heavy mechanized military vehicles significantly impacts sustainability on the base's maneuver training areas. As soils and vegetation are degraded, runoff and associated sediment loads increase in surrounding waterbodies. Application of composted dairy manure to the training areas helps to increase organic matter in the soil, reduce erosion, and aid in vegetative growth, keeping sediment out of water sources.

Several areas within Fort Hood have already benefited from applications of dairy manure compost, and additional demonstrations are being established this fall to revegetate barren soils along roadways.

"By applying compost to this area and evaluating vegetation establishment, researchers can determine proper compost rates and seed mixes to serve the needs of Fort Hood," said Fox. "It will help to address the area's environmental concerns while at the same time preserving the integrity of Fort Hood's training facilities."

Standardizing Secondary Wastewater Treatment

Subsurface Flow Constructed Wetlands

by Kellie Potucek

As the population in Texas' rural and suburban regions rapidly increases, there is an escalating need for permitted onsite wastewater treatment systems. In order to qualify for a permit, stringent standards must be met to guarantee the quality of water released from a system.

In loamy soil areas, conventional treatment of wastewater via a septic tank and soil absorption field, or *drain field*, is generally adequate. In this type of system, wastewater enters the watertight septic tank, where solids separate out and are partially digested by microorganisms. The wastewater then empties into a soil absorption field through perforated pipes for final treatment and distribution.

"This system relies heavily on the soil, where microorganisms help remove organic matter, solids and nutrients left in the water," explained Bruce Lesikar, extension specialist of the Texas A&M University Department of Biological and Agricultural Engineering.

However, many areas of Texas have soils that do not sufficiently absorb and treat organic and microbial pollutants. In these regions, drain fields are required to be very large, making them uneconomical. Therefore, these areas require additional secondary or advanced treatment of effluent.

When properly built, subsurface flow constructed wetlands (SFCW) are a means of providing necessary additional processing. In systems with SFCWs, a septic tank is used for initial treatment. Then, wastewater travels through a header and into the wetland for further cleansing. Graded stones are typically used to construct the bed of the wetlands and aquatic plants are introduced. SFCW vegetation naturally filters suspended solids, organic matter, excess nutrients and harmful pathogens, leaving treated wastewater ready for dispersion into an average size soil absorption field.

While SFCWs have become increasingly popular for domestic wastewater treatment, there has yet to be a standard model from which they can be designed. The United States Environmental Protection Agency's (EPA) most precise model suggestion is that the organic matter, or biochemical oxygen demand, should have an area loading rate of 6 g/m^2 per day with a maximum effluent concentration of 30 mg/L. Beyond this guideline, the EPA merely makes suggestions for parameters such as depth, length to width ratio and inlet/outlet design.

Rebecca Hobbs, of the Texas A&M University's Department of Soil and Crop Sciences, is researching individual aspects of SFCWs in order to improve the efficiency and consistency of their output. "If the effects of wetland parameters can be better understood, the design criteria for those parameters can be further developed and optimized," explained Hobbs.

In one aspect of her research, Hobbs is investigating how the method of wastewater introduction into the wetland affects the efficacy of treatment. There are currently several header designs that transfer wastewater from the septic tank into the wetland. Hobbs is focussing on two header designs: the traditional perforated pipe and the more contemporary leaching chamber. In the perforated pipe design, a slotted pipe is used in an effort to evenly distribute effluent into the wetland. The leaching chamber design involves a plastic compartment that allows a place for organic material to collect before it releases water into the wetland.

Early results of Hobbs' bromide tracer studies indicate that leaching chambers do not evenly distribute water through the wetland. In one case, her team removed a chamber, replacing it with a perforated pipe that spanned the entire width of the wetland. "We saw immediate improvements in the quality of water coming out of that wetland," reported Hobbs.

Hobbs is also testing several length to width ratios, also referred to as *aspect ratios*. Specifically, Hobbs is testing 2:1 versus 1:1 versus 4:1 aspect ratios in an effort to determine whether wetlands work better if they are long and narrow or short and wide. She is currently in the data collection stage of this aspect of the study.

Hobbs supports the use of SFCWs as a low cost operation that helps guarantee water quality. Her research will help standardize optimal construction of these wetlands, providing new rural and suburban homeowners with an economical and efficient method to treat their domestic wastewater.

New Technologies Aim to Remove Excess Phosphorus

by Jenna Smith

Dairies within the Bosque and Leon River Watersheds will soon have the opportunity to participate in a program directed to assess a variety of technologies, which can decrease the level of phosphorus in dairy manure and process-generated wastewater.

Current dairy waste management systems utilize lagoons, which store and treat process water and other runoff waste. When lagoon effluent is irrigated onto waste application fields, it supplies essential plant nutrients including phosphorus (P) to receiving soils. If more P from effluent is applied than can be utilized by crops and pastures then over time, P levels can increase and runoff events from these fields may contribute excess nutrients to nearby waterways.

According to Saqib Mukhtar, associate professor and extension specialist with the Texas A&M University Department of Biological and Agricultural Engineering, utilizing technologies that remove or reduce the phosphorus content of dairy manure effluent will allow dairy operators to continue to apply the low P effluent to waste application fields without increasing soil P levels.

Since the historical use and performance of these technologies on dairy waste is limited, Mukhtar will lead a new project conducted by Texas Cooperative Extension and the Texas Water Resources Institute. The principal goal of this project is to provide a third party evaluation of selected technologies designed to reduce P levels in dairy manure effluent without negatively affecting onsite waste management systems or other waste constituents.

The project, funded by the Texas State Soil and Water Conservation Board through the Environmental Protection Agency Clean Water Act, will be implemented over the next three years on cooperating dairy operations within the Bosque and Leon River Watersheds. Two technologies will be selected each year and implemented in each of the two impacted watersheds.

"Electrocoagulation Technology" and "Phosphorus Removal by Chemical Precipitation and Geotube®" were selected for first year evaluation. The OSVE Dairy in the Bosque River Watershed and the Triple X Dairy in the Leon River Watershed will both cooperate with technology providers and project administrators to implement and evaluate performance efficacy. Both of these dairies use anaerobic lagoons to remove, store, treat, and land-apply effluent (manure and process-generated wastewater).

"Both Geotube® and Electrocoagulation will use two different technological methods to treat raw material and analyze the sludge or by-product for P stability," said Mukhtar. "This testing is designed to reduce water quality impairment associated with animal production systems, specifically dairies."

The Geotube® method will use chemical precipitation and Geotube dewatering of animal waste to remove P in raw, liquid manure. By utilizing Alum, a chemical proven to bind P from an animal waste stream, P will be rendered insoluble, unreactive and unavailable as a plant nutrient.

Electrocoagulation, on the other hand, will utilize aluminum and iron electrodes and electrical current for P removal. As animal wastewater flows through a series of electrodes, the electrical energy causes the contaminated wastewater to separate into an organic rich floating layer, a mineral rich sediment and clean water.

Besides reducing P levels in the dairy manure for continued, beneficial application on waste application fields, the technologies may potentially help reuse the treated water within the dairy operations for wash water, drinking water, misters and other on-site activities.

Photos (left to right) describe 1) Geotube® technology personnel experimentally mix alum and a polyacrylamide polymer to bind phosphorus in dairy effluent at Triple X Dairy near Comanche, Texas, 2) Interaction with chemical additives separates dairy effluent into solid and liquid layer, 3) Treated effluent is filtered through Geotube® material and water is collected to determine amount of phosphorus reduction achieved by technology, and 4) Geotube® technology in place on a dairy operation.

Photos courtesy of Saqib Mukhtar

A Balancing Act

Freshwater Flow to Estuaries

by Kellie Potucek

Both humans and animals benefit from the many functions of tidal wetlands located in estuaries. One illustration of their importance lies in the marshes' ability to improve water quality. Marshes trap suspended sediment and help alleviate flooding problems associated with rainstorms. Furthermore, as sources of food and habitat, the wetlands are vital to the existence of dozens of avian, mammal, fish, and invertebrate species.

The balance between freshwater inflow and tidal flushing of salt water breathes life into the unique ecosystems. In many Texas estuaries, this balance may be altered due to sea level rise, subsidence, and human activities that divert fresh water from the areas. Changes in structure or function in wetlands along the Guadalupe Estuary are especially troubling because they serve as winter refuge to the endangered Whooping Crane.

Rachel E. Butzler, of the Department of Wildlife and Fisheries Science at Texas A&M University, is researching variations in freshwater flows into tidal marshes in the Guadalupe Estuary. Butzler's research is focused on effects to vegetation, with special attention to Carolina Wolfberry, a plant that comprises 21 to 51 percent of the Crane's energy intake early in the wintering period. The Guadalupe estuary is located along the Gulf of Mexico where the San Antonio and Guadalupe Rivers empty into San Antonio Bay. The study area was established in salt marshes of the Aransas National Wildlife Refuge (ANWR). In her research, Butzler is working to ascertain the spatial and temporal variability of vegetation, or *macrophytes*, in the region. Additionally, she is tracking the changes of the Carolina Wolfberry in relation to field measurements of salinity and flooding, or *inundation*.

"This study can help predict how variations in salinity and inundation will affect recruitment, production, and growth patterns of the Carolina Wolfberry, which provides food for marsh species, specifically the Whooping Crane," explained Butzler. While other studies briefly reference the Carolina Wolfberry, Butzler's research focuses on the plant because of its importance as a food resource.

In the fall of 2003, Butzler established three data collection sites along the estuarine gradient: a boat ramp close to the Guadalupe River mouth, a pump canal that serves as an intermediate site and a point in Sundown Bay, which is most influenced by the gulf. Temperature, dissolved oxygen and salinity were measured every 30 minutes by a water sampler to monitor water quality parameters along the gradient. Vegetation was harvested along transects at the three sites to characterize plant communities and estimate Wolfberry abundance across the marsh. Soil cores were taken to determine organic matter and nutrient content, which may play a role in plant distribution. Additionally, Butzler established macrophyte plots as a non-destructive method to measure the composition of vegetative species and aboveground biomass of the Carolina Wolfberry. Salinity levels of standing water in these plots were also measured.

"Of the three sites, the boat ramp seems to support the highest macrophyte diversity, followed by the pump canal and then Sundown Bay," reported Butzler. Preliminary results suggest correlation to the salinity levels in each site, which were lowest at the boat ramp and increased at the pump canal and Sundown Bay sites, respectively. This variation also corresponds to inundation which orrcurs most frequently at Sundown Bay and least frequently at the Boat Ramp. Monthly sampling will continue until March 2005, the end of the growing season. However, sampling will continue as part of a larger ecosystem project. Furthermore, Butzler is planning a greenhouse experiment for the fall in which she will test salinity and inundation effects on Carolina Wolfberry in a controlled environment.

"This continued research will further clarify the role of salinity and inundation in governing marsh community dynamics and wolfberry production at ANWR," explained Butzler. As part of a larger ecosystem study, these results will be combined with other components and used in making management decisions. These findings may also apply to other estuarine watersheds that are facing the same pressures as the Guadalupe Estuary.

Mills Scholarship Recipients Named

by Jenna Smith

The Texas Water Resources Institute (TWRI) recently awarded 16 scholarships to Texas A&M University graduate students pursuing research related to water resources. These grants were awarded through TWRI's Mills Scholars program and will assist graduate students in the 2004-05 academic year.

TWRI uses the Mills Scholars program to encourage and assist current and prospective graduate students to incorporate water resources studies into their graduate programs. Some of the research projects being studied by this year's Mills Scholars include decentralized wastewater management, brush water consumption assessment and control, stochastic modeling of above and below-ground water systems, and quantification and understanding of methylated arsenic. Other graduate students in this program are researching attitudes, knowledge and perceptions of water use among varying demographics; creating watermelon lines that require little or no irrigation; and how to manage and restore dams.

The winners, their departments and project titles can be found in a chart on page 8.

*See **Mills** on page 8*

For more information visit http://twri.tamu.edu and click on Mills Scholarships under the Funding Programs section.

continued from page 7

2004 Texas A&M University Mills Scholarship Recipients

Name	Department	Project Title
David Bell	Agricultural Economics	Modeling above and below-ground water systems in Texas in order to fully integrate water as an input in municipal and sectoral economics of Texas
Matt Berg	Rangeland Ecology and Management	Wetland restoration and ecology
Robert Eyeington	Wildlife and Fisheries Sciences	Response of amphibians to variation in landscape features and vegetation cover in the Pedernales River Basin
Lucas Gregory	Rangeland Ecology and Management	Quantifying the affects of woody plant encroachment in semi-arid landscapes on the total water budget
David Hoeinghaus	Wildlife and Fisheries Sciences	Food web ecology in the Parana River Basin
Jeremy Hudgeons	Entomology	Physiological affects of beetle defoliation on saltcedar trees
Euclides Jasso	Soil and Crop Sciences	Investigation of isotopic fluxes from grassland and woodland sites in the Edwards Plateau of Texas
Robert Jones	Soil and Crop Sciences	Methylated arsenic species interaction at soils – water interface
Tara Kneeshaw	Geology and Geophysics	Understanding the fate and transport of chemicals in subsurface systems
Leslie McKendrick	Agricultural Education	Perceptions and attitudes that influence how individuals value water
Heather Miller	Geology and Geophysics	Water management, soil salinity and landscape ecology in Laguna Atascosa National Wildlife Refuge
Nena Phillips	Rangeland Ecology and Management	Effect of habit changes in an near San Antonio Bay and its effect of whooping cranes
David Rosen	Rangeland Ecology and Management	Taxonomic and ecological study of select members of the subgeus *Limnochloa* in the sedge genus *Elcharis* on middle and lower Texas Coast
Karen Sell	Geology and Geophysics	The microbial responses to stressors across watershed system boundaries
Travis Waiser	Soil and Crop Sciences	Effectiveness of diffuse reflectance spectroscopy on measuring soil properties *in situ* - Bosque River Watershed in Erath County
Jennifer Waters	Vegetable and Fruit Improvement Center	Introduction of *Arabidopis thaliana* genes to create drought tolerant watermelons

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