



2018 ANNUAL REPORT  
**Utah Water Research Laboratory**



**Mac McKee**  
UWRL Director

In a few months, I will retire and step down as Director of the Utah Water Research Laboratory (UWRL). As this change in direction approaches I am reminded of the common adage, “The more things change, the more they stay the same.” Actually, this aphorism accurately describes both the ancient and current condition of water engineering and management, and in some ways, it sets the agenda for our work at the UWRL.

An example might help clarify: Ancient Egyptian pharaonic priests, scribes, and bureaucrats understood that the level of the Nile River, as measured at certain times and locations during the year using a “nilometer,” a device closely resembling a modern stage gauge, could be used to forecast the agricultural harvest that would occur later in the year. This information was used to anticipate future agricultural production and tax revenues, manage agricultural lands and irrigation systems, and generally support government operations and infrastructure in ways that produced better social results, at least as defined by the pharaoh.

While the ancient Egyptians did not understand the hydrologic system governing the Nile's flow nor the intricacies of the agricultural and social systems they were managing, their knowledge was “close enough” to measure, forecast, and manage their water resources. In extremely dire hydrologic conditions, however, their imperfect knowledge of these systems at times led to catastrophic economic and social system failures. Things are no different today. However, our expanding

capacity to measure (monitor), forecast (model) and manage water resources can help us avoid such failures, more effectively administer severe hydrologic challenges, and improve on normal operations.

Since its creation, faculty and students at the UWRL have continually developed new and better ways to monitor, model, and manage the hydrologic and related environmental systems of the State, the nation, and the world. This report illustrates a few examples of such research that are improving our understanding of new technologies for low-head hydroelectric power production (modeling), providing easier identification of unnecessary energy losses in the USU campus infrastructure (monitoring), and designing options for balancing the allocation of water between competing summer demands on a small Utah stream (management).

These stories exemplify the important, applied research conducted every day at the UWRL. As I look toward retirement in a few months, I must say that I am extremely proud of the advances that our researchers have achieved. We are national and international leaders in research in hydrologic cyberinformatics, in drone- and satellite-based remote sensing, in the operational behavior of hydraulic control structures, and in many other important areas. I will miss this excitement, and, most of all, I will miss the brilliant UWRL faculty and student researchers who make it all happen.

This report is only a brief snapshot of the wide range of research ongoing at the UWRL. For more information, please visit our website at:

<http://uwrl.usu.edu/>



# Contents

## Project Highlights..... 4-11

Environmental Research is in the Air: from Utah to Palestine and back again ..... 4

Making a Difference: hydraulic modeling & testing at the UWRL ..... 8

The Power of Water: testing a new, full-scale turbine design..... 10

## Focus on Utah ..... 12-15

Seeing Heat: energy-loss mapping on campus with AggieAir™ ..... 12

Balancing Summer Water Needs in the Blacksmith Fork River ..... 14

## Awards/Achievements ..... 16-17

Turning Food Waste into Energy: an award-winning proposition ..... 16

Other Awards/Achievements..... 17

## FY 17-18 Financial / Academic Summary ..... 18-19

Trent Balin helping to install the Percheron Power full scale turbine prototype at the UWRL.



# Environmental Research is in the Air: from Utah to Palestine and back again

Dr. Randy Martin's recent Fulbright  
Fellowship experience has been  
a culmination of sorts...  
...and a continuation

When Dr. Randy Martin came to USU in the summer of 2000, he unknowingly landed at the epicenter of some significant air quality challenges. Since his arrival, he has completed dozens of studies and analyses of atmospheric trace species, particularly with reactive hydrocarbons and related oxidation products. Dr. Martin has become well known for his expertise in the characterization and behavior of ambient fine particulate matter, known as PM<sub>2.5</sub> and PM<sub>10</sub>. As his research program and experience developed at USU, so did his connections among the academic and research community.

Earlier this year, Dr. Martin served as a lead researcher in one of the largest air quality studies ever conducted in Utah. He and colleagues from the Utah Department of Environmental Quality, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration and the University of Utah performed a major study aimed at better understanding the chemical and atmospheric conditions that contribute to Utah's wintertime air pollution. The study involved ground-based measurement stations and a specially equipped NOAA aircraft that collected trace gases and aerosols in Salt Lake and Cache valleys. He was also recently appointed to Utah's Air Quality Board.

His other regional air quality research has investigated:

- ▶ excessive PM<sub>2.5</sub> pollution in the wintertime atmospheres of northern Utah's urban valleys

- ▶ agricultural air pollutant contributions to local and regional airshed
- ▶ the growing importance of ambient ammonia sources and atmospheric behavior
- ▶ wintertime ozone in the Uinta Basin
- ▶ summertime ozone over the Great Salt Lake
- ▶ mobile source emissions relevant to Utah's vehicle fleet and climatic conditions

Clearly, Dr. Martin knows his way around some of Utah's most pressing air quality problems, so what took him half way around the world to study the air over Palestine? That journey began with a quick trip to Palestine in 2009 to participate in a series of air pollution workshops sponsored by the U.S. State Department, and perhaps even before that when he presented his regular biennial Cache Valley air quality update in a weekly Environmental Engineering Seminar at USU in 2008.

### The Palestine Connection

In the audience was Abdelhaleem (Abed) Khader, a USU graduate student from Palestine studying network design for groundwater quality monitoring.

As Abed listened to Dr. Martin's presentation, he was intrigued. The topography and pollution sources in Cache Valley and Palestine were quite similar. Could he implement similar research in his home country?

Eight years later, Dr. Khader had graduated from USU, completed a post-doctoral fellowship in Canada, and returned to Palestine to teach environmental engineering at An-Najah National University in Nablus. He had become more convinced than ever of the need for air quality research; however, Palestine simply did not have the local research nor the infrastructure necessary to perform the research, despite the rapidly growing air pollution sources and the noticeable increase in air quality related illnesses.

### Palestine to Utah

Dr. Khader applied for and received a research (Zamala) fellowship through his university to study with Dr. Martin's research group for a few weeks during summer 2016 as a visiting scholar. During his time back at USU, Dr. Khader:

- ▶ Developed his own cooperative project investigating auto emissions as a function of gender and driving experience.
- ▶ Experimented with ways to build particle sensors from readily available, low-cost parts.
- ▶ Analyzed a large particle size distribution data set from the previous winter's Salt Lake City air quality study collected using an advanced Grimm optical particle counter.

As Dr. Khader returned to Palestine to initiate an air quality research program there, Dr. Martin applied for and received a Fulbright Flex Fellowship that allowed him

to work with Dr. Khader at An-Najah National University in spring semester 2018 and to revisit during spring 2019 for a workshop/conference and program assessment.

## Utah to Palestine

His Fulbright program objective was to develop an active and sustainable air quality

education and research program at An-Najah National University in Nablus.

To accomplish this objective required a multi-faceted approach:

- ▶ Assess the available equipment at An-Najah, which revealed limited and outdated equipment

- ▶ Permanently donate the essential equipment to complete the planned and future research.
- ▶ Create a graduate level course to teach the students how to measure and understand air quality issues, teaching concepts of gaseous & pollutant emissions, behavior, and control, along with modeling and meteorology.

## Equipment Donated

- **An Air Metric Portable MiniVol PM<sub>2.5</sub>/PM<sub>10</sub> filter-based sampler system**—accepted by USEPA as a Federal Equivalent Method (reliable, accurate) that can be used to locally calibrate OPC-based systems.
- **(4) University of Utah's AirU real-time PM monitors**—portable, low cost monitors based on optical particle counting that must be calibrated to local dust densities and optical properties
- **An MQ-131 ozone sensor and support electronics**—a low-cost semi-conductor sensor--a relative indicator rather than regulatory. Similar sensors were found to be available locally.
- **A Contec SP10 Spirometer**—used to measure human lung function for possible air pollution impact studies

## Some Established Research Projects

- **Nablus Dust Storms Impact**—Examined potential changes in PM<sub>2.5</sub> and PM<sub>10</sub> concentrations during regional dust storms. Deployed 3 calibrated AirU monitors around Nablus
- **PM Levels in Typical Smoke Shops**—Measured PM<sub>2.5</sub> and PM<sub>10</sub> concentrations at different shops during social events
- **Nablus Lung Function Study**—Continuation of previous graduate student class project. Measured local PM<sub>2.5</sub>/PM<sub>10</sub> concentrations and lung function of adults at four different locations: quarry workers, roadside workers, chemical cleaning workers, and rural workers, along with a similar study at boys/girls schools close to the adult worker locations



- ▶ Established research projects to give the students practical experience and complement their theoretical foundation as well as integrated the experience to semester design projects.
- ▶ Met with the Palestinian EQA Minister. At first, she did not believe Palestine had an air pollution problem, but Dr. Martin convinced her that the data indicated otherwise.

## The Connection Continues

Even as Dr. Martin headed back for his follow-up visit to An Najah in March 2019, Dr. Khader is getting ready to return to the UWRL as a visiting scholar on his own Fulbright Scholar Award in summer 2019. And there is plenty of research waiting for him, including ongoing research into ammonia & HCl along the Wasatch Front and dynamometer and on-road vehicular emission studies in collaboration with USU, WSU, and UDAQ.



An-Najah National University in Nablus, Palestine (above left) and the Engineering School graduation celebration at An-Najah (above right).

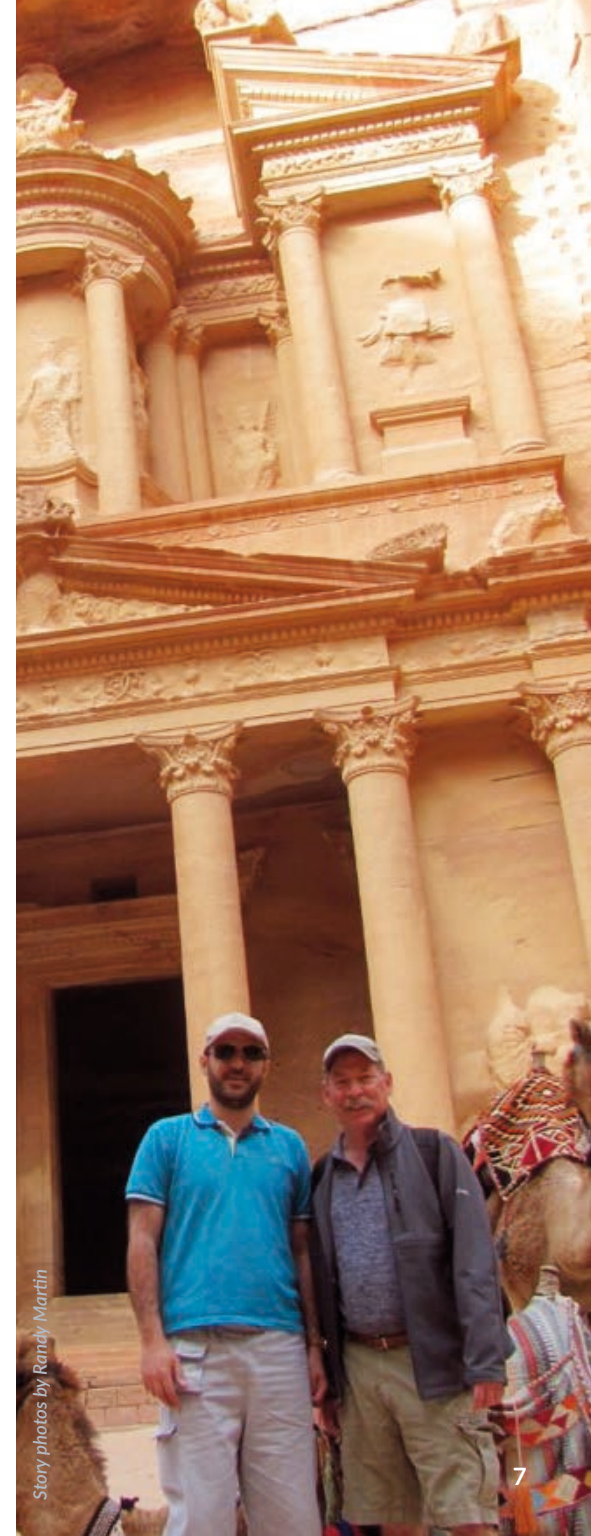


Dr. Martin and Dr. Khader with their environmental engineering graduate students at An-Najah (left) and fulfilling another Fulbright objective, which is to enhance cultural experiences. Shown here from among many cultural events are Dr. Martin at the Dome of the Rock on Temple Mount in Old Jerusalem (above) and Drs. Martin and Khader at the "Treasury" at Petra in Jordan (right).

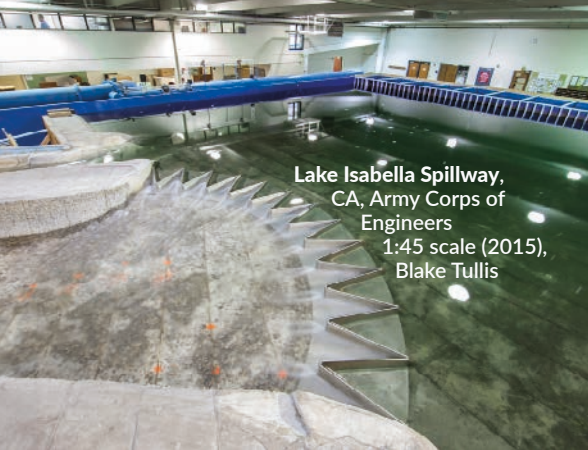
## Why Connecting is Important

So what are the benefits of working with researchers half a world away? According to Dr. Martin, "Sharing my passion for researching and understanding air quality with a region of the world where air pollution and its impacts have been relatively low on their radar has been an amazing experience. It has refreshed my motivation as I have seen the growing interest in the students and people of An-Najah and the Nablus region."

And beyond the research, he says that "experiencing the culture, traditions, and history of the region person to person greatly increased my appreciation of both the differences and the similarities between the culture of the Palestinian people and my own. The questions and the problems are basically the same, but maybe our answers will be better as we connect and broaden our views." ■



# Making a Difference:



Lake Isabella Spillway,  
CA, Army Corps of  
Engineers  
1:45 scale (2015),  
Blake Tullis

## Shaping Engineering Design

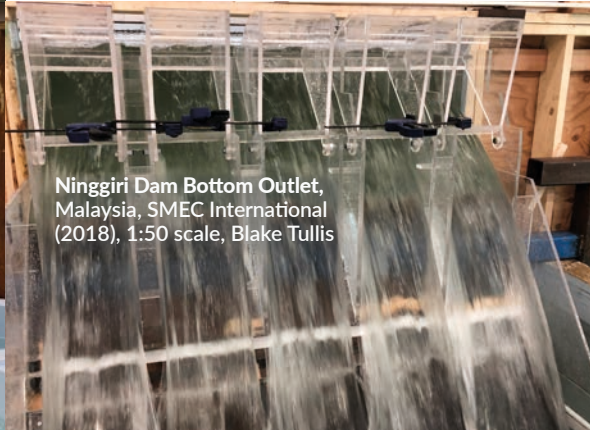
The applied research ongoing at the UWRL is changing the way engineers design hydraulic structures. For example, Brian Crookston's graduate research on arced labyrinth weirs was used by the Army Corps of Engineers to design a new spillway for the Lake Isabella dam in California. Another example right here in Utah is the Millsite dam near Ferron, UT, which was redesigned based on UWRL design specifications from applied research.



Andy Lee welding the laser-cut precision topography onto the Oroville Dam 1:50 scale model.



Lake Ralph Hall  
Spillway, TX,  
Freese and  
Nichols, Inc.  
1:12 scale  
(2018),  
Blake Tullis



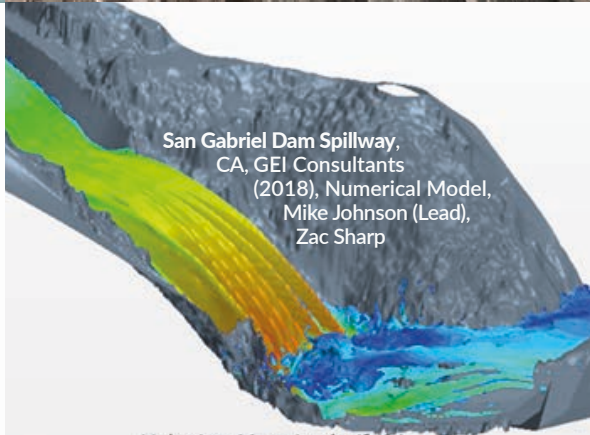
Ninggiri Dam Bottom Outlet,  
Malaysia, SMEC International  
(2018), 1:50 scale, Blake Tullis

## Validating Engineering Design

New hydraulic structures such as dam spillways or pumping facilities represent an enormous public investment. Testing and calibrating hydraulic structures at the UWRL using physical and numerical models allows engineers to verify their designs prior to construction to:

- reduce uncertainty
- reduce costs
- ensure public safety

**~\$1.5 million**  
awarded in FY 2018  
for large physical and  
numerical models



San Gabriel Dam Spillway,  
CA, GEI Consultants  
(2018), Numerical Model,  
Mike Johnson (Lead),  
Zac Sharp

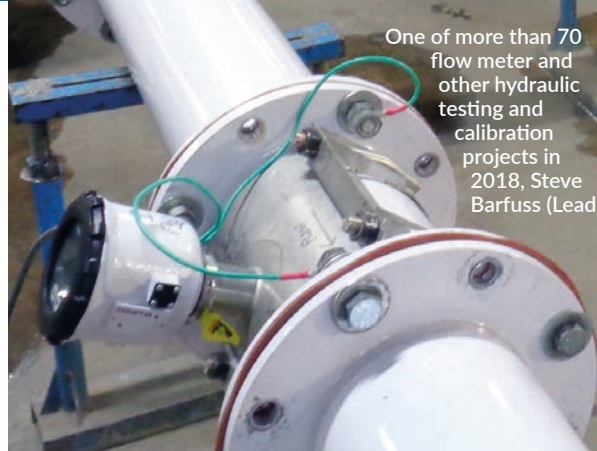


Oroville  
Dam Spillway, CA,  
GEI Consultants (2017-18), 1:50 scale,  
Mike Johnson (Lead), Zac Sharp

# hydraulic modeling & testing at the UWRL

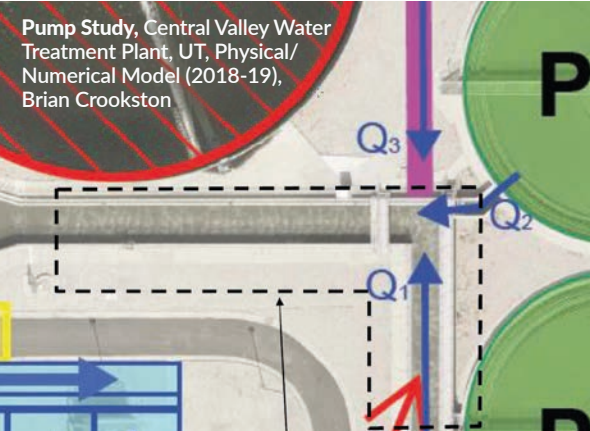
## Training Future Experts

Fifteen students, technicians and research engineers worked with the UWRL hydraulics faculty in 2018 building models and testing hydraulic structures. The hydraulic research and testing performed at the UWRL provides valuable hands-on experience addressing real engineering questions and prepares our students and researchers to become the next generation of hydraulics experts in Utah and beyond.



One of more than 70 flow meter and other hydraulic testing and calibration projects in 2018, Steve Barfuss (Lead)

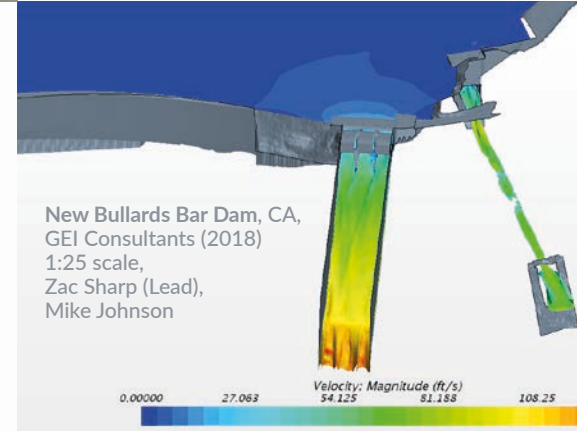
An additional  
**~\$1.5 million**  
received in FY 2018  
for hydraulic testing  
and calibration



Pump Study, Central Valley Water Treatment Plant, UT, Physical/Numerical Model (2018-19), Brian Crookston

## Brian Crookston, PhD, PE

*Assistant Professor of Hydraulics*—Dr. Crookston has spent the past seven years at Schnabel Engineering in their West Chester, Pennsylvania, office after studying Water Resources Engineering at USU. His research and consulting interests are focused on water conveyance, including the design of hydraulic structures, fluvial hydraulics, dam safety, nonlinear spillways, and physical and numerical modeling.



New Bullards Bar Dam, CA, GEI Consultants (2018) 1:25 scale, Zac Sharp (Lead), Mike Johnson



Archimedes' Screw Turbine, Percheron Power (2018) full scale, Mike Johnson

## New Faculty Members



Brian Crookston



Zac Sharp

## Zachary Sharp, PhD, PE

*Assistant Research Professor of Hydraulics*—Dr. Sharp graduated in CEE from USU. He specializes in performing hydraulic physical and numerical model studies on dams and spillways, power plant intakes, pump station designs, and many other water-related applications. He also specializes in lab and field testing of valves and flow meters using physical and/or numerical techniques.

# The Power of Water:

testing a new, full-scale turbine design



Photos for hydraulics stories by Matt Jensen & UWRL

Installed turbine with student Taylor Stauffer, PI Michael Johnson, Percheron principals Jerry Straalsund and Sharon Atkin, and student Trent Balin (above); turbine installation (below).



**W**hen Percheron Power of Kennewick, Washington, was looking for someone to test their unique design for a water powered turbine, they looked to the Utah Water Research Laboratory (UWRL), one of the few laboratories in the US that could accommodate the 22,000-lb, 42-ft, full-scale prototype modeled after the ancient Archimedes' screw.

The idea behind this type of turbine is to use distributed power instead of a centralized power plant. The turbines can be installed in a number of smaller locations, wherever water is flowing, which spreads power production out and brings it closer to consumers. This concept has several potential benefits over centralized power distribution:

- ▶ increased security of the power grid
- ▶ reduced cost of power delivery
- ▶ minimal impact on fish and the environment

This hydrodynamic screw was designed and developed by Percheron Power under a cooperative agreement supported by the U.S. Department of Energy. Company principals Jerry Straalsund and Sharon Atkin say this type of hydro turbine has been installed in hundreds of locations in Europe over the past decade, but so far, there is only one in the U.S.

The turbine is the first of its kind to be tested in the U.S. at full scale inside a

laboratory environment. Lead engineer, Michael Johnson, and his team constructed a custom test rig inside the Hydraulics Modeling Lab.

"During testing, we looked at multiple variables to enable Percheron Power to prove their design and demonstrate the viability of their technology," said Johnson. "It's exciting to be involved on a prototype test project of this scale and to assist Percheron Power with this turbine design that has such incredible potential."

Current industry practice uses steel, but this turbine is made of composite materials. Percheron developed a new process to produce the turbine's individual blade segments that uses an advanced manufacturing method called Light Resin Transfer Molding. Straalsund and Atkin say their optimized turbine will result in lower installed costs and improved hydraulic efficiencies compared to existing steel Archimedes' turbines. The composite turbines are made in the U.S. and will be available to North American customers without the need to import large steel assemblies.

Unlike solar and wind power, hydro-turbines offer continuous energy as long as water is flowing. The company is reviewing existing man-made structures, including canals, dams and weirs, as potential locations for its hydro turbines. Percheron says the turbines are rugged and easy to

operate and are proven to have very little impact on fish.

"We are very committed to developing cost-effective and environmentally-friendly technologies for distributed power generation," said Straalsund. "Our vision is to offer modular systems that can be shipped and readily assembled at the hydro-plant site."

A turbine of this size can produce about 35 KW of power--enough energy to power several homes in the US or a small village or mill in a developing country. Percheron has turbines of the same design that can be more than twice as large and produce more than 350 KW. Archimedes' screw turbines can be used as stand-alone power sources or connected to the grid.

**"It** was exciting for all of us to see water flowing through the new turbine and producing power for the very first time," said Atkin. "We feel fortunate to have a world-class resource like the Water Lab (UWRL) as a partner for testing our turbine."

# Focus on UTAH:



## Seeing Heat: energy-loss mapping on campus with AggieAir™

The USU Facilities Department has the daunting task of keeping all of the buildings on the USU campus in top condition. That includes looking for areas to improve energy efficiency. With well over one hundred buildings on campus, even small energy inefficiencies can add up fast. That is why Facilities recently turned to AggieAir™, a UWRL Service Center specializing in the development and use of small unmanned aerial systems for collecting scientific imagery and data, to help them identify energy waste on campus.

Using their smallest UAV, the Matrice 600 Pro, the AggieAir team collected thermal imagery that will help map hot and cold areas associated with buildings, equipment, and utility distribution on the USU Campus. Matrice 600 Pro was flown twice, once just after sunrise, and then again at solar noon. Together, the two flights provided all the information needed to assess the situation.

Thermal imagery is more accurate in the morning because contrast between hot and cold temperatures is greater. However, optical contrast is low in the early morning, so the flight at solar noon gives the clearest imagery of the campus buildings. The team then overlaps the imagery from both flights to create the most accurate thermal map of campus.

With AggieAir's data, Facilities will be able to locate buildings that may be experiencing above average losses of hot or cold air, and come up with ways to prevent or decrease them. As Zachary Cook, Utilities Energy Manager at Facilities, stated, "We hope to identify electric heat tape or snowmelt systems that may be running when they shouldn't, losses through leaking building envelopes, and any number of other possible issues." Fixing these problems will reduce energy costs and is an essential step towards achieving the University's sustainability goals.

With the success of these first heat mapping flights at the main Logan campus, USU Facilities is now aiming for an even smaller target—leaks in the steam pipes that run under the ground at the USU Eastern campus in Price, UT. AggieAir's high-resolution multispectral imagery will make locating these underground steam leaks a much easier task.

Although USU Facilities has performed heat mapping in the past, previous efforts

Photo by Ian Gowing

**W**ith AggieAir's data, USU Facilities will be able to locate buildings that may be experiencing above average losses of hot or cold air and come up with ways to prevent or decrease those losses.



used small manned aircraft that had to be flown at a higher altitude and came with a bigger price tag. AggieAir makes gathering this type of data faster and much less expensive. The thermal imaging gained from the AggieAir sensors also has much higher quality and clarity than the data gathered in the past, giving the Facilities team greater knowledge of exact locations that may be losing heat, whether it be at the pipe or building scale. ■

More information at:  
<http://aggieair.usu.edu>

## AggieAir in Utah & Beyond!

AggieAir technology was originally developed specifically for water resources applications, but possibilities developed over the past year show that AggieAir has a much broader application:

- AggieAir was heavily engaged in support of a major piece of research on **water use and irrigation for high-value crops such as wine grapes** (this USDA research was featured in the September issue of the Bulletin of the American Meteorological Society)
- FAA granted AggieAir their **largest and most expansive COAs** to date, allowing them access to more airspace than any other small UAV in operation.
- Deseret UAS is collaborating with AggieAir as they working toward **Beyond Visual Line of Sight** operation.
- Makers of a 700 lb. scale model of a well-advanced design for a flying **unmanned taxi service** have shown interest in using AggieAir to test their model. AggieAir has the airspace permissions to make those tests possible.

# Focus on



Photo by Madison Alger

*Dr. Belize Lane and Joe Kotynek of the USU Buglab collecting aquatic macroinvertebrates with drift nets in the Blacksmith Fork River, Utah*

# UTAH:

## Balancing Summer Water Needs in the Blacksmith Fork River

Utah is one of the driest and fastest growing states in the US, with limited water resources that are under increasing pressure and uncertainty for meeting both human and environmental needs in the future. For example, in dry summers, irrigation diversions dewater lowland river reaches. Such conditions negatively affect native trout populations, which then take years to recover. Water resources managers need a better understanding of the ecological consequences of flow alteration in order to address these and other water management challenges.

Drs. Belize Lane and Bethany Neilson, along with their research teams, are examining how aquatic biota respond to changes in streamflow in the Lower Blacksmith Fork River near Nibley, Utah, as a basis for developing predictive tools to inform better water management decisions. The teams are monitoring several parameters over the summer low-flow period to better quantify the ecological consequences of flow alteration. Parameters of interest include:

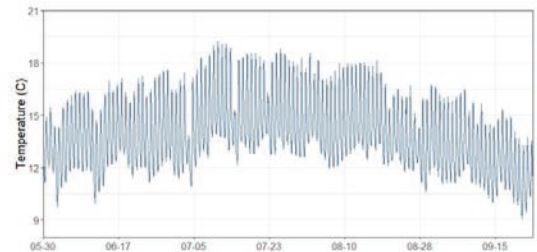
- ▶ trends in streamflow
- ▶ groundwater exchange
- ▶ water temperature
- ▶ macroinvertebrate drift

Understanding the flow-temperature-ecology relationships will allow the teams to assess more accurately the tradeoffs between water uses and to propose improvements to coupled human-environmental water management in northern Utah to benefit both farmers and fish, particularly in lowland agricultural regions downstream from mountain canyons. These agricultural reaches often constrain connectivity and river health between more pristine canyons upstream and productive floodplains downstream.

This field-intensive project will provide information to quantify the limiting

streamflow and temperature conditions and locations for native and recreational trout fisheries in the Lower Blacksmith Fork River. The researchers are developing a set of minimum water quantity and quality requirements based on discharge, water temperature, and groundwater exchange patterns recorded along the study reach, that managers can use to determine the water flow needed in the river to maintain fish throughout the hot, dry summer months.

The physical river parameters monitored over summer 2018 will be monitored again in summer 2019 to compare outcomes in different antecedent climate conditions. The teams are also working with Trout Unlimited and the City of Nibley to support sustainable water management for humans and ecosystems functioning under increasing pressure and uncertainty. ■



River instrumentation deployed between the Nibley Blacksmith Fork and Millville Providence Blacksmith Fork Lower canals over summer 2018. The UWRL's AggieAir™ UAVs were used to collect aerial and thermal imagery to assess spatial patterns of water temperature.

# Turning Food Waste into Energy: an award-winning proposition

A team of USU engineering students recently earned a national award for their design that will help one of Utah's wastewater treatment facilities to increase production of renewable energy using food waste as a biofuel feed stock.

Their plan for optimizing the performance of the wastewater treatment plant's anaerobic digestion system increases both the volume of biogas produced and the volume of food waste treated at the facility.

## The Competition

Each year the design competition, which is sponsored by the Water Environment Federation as part of their Annual Technical Exhibition and Conference (WEFTEC), asks student groups to address real industry needs. This year 12 teams

from the US and Canada competed, with USU and U. of South Florida tying for 2<sup>nd</sup> place in the wastewater design category.

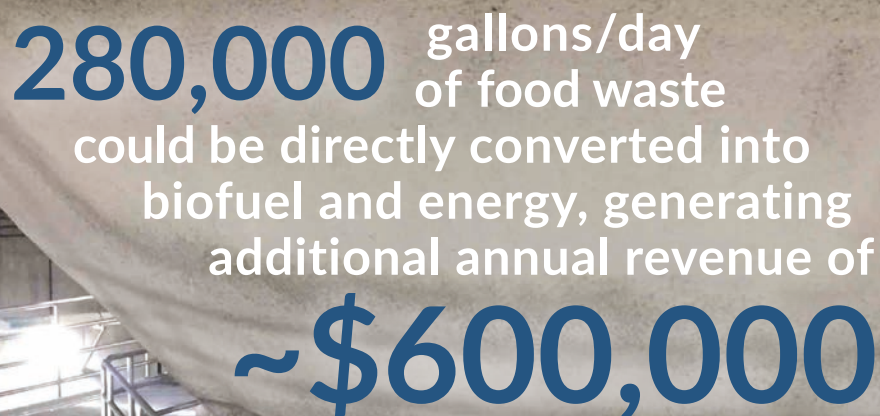
The USU team, mentored by UWRL faculty member Ryan Dupont, assessed several alternatives to improve anaerobic wastewater treatment at the Central Valley Water Reclamation Facility in Salt Lake City, Utah. The anaerobic process deals with primary solids. The students were working to find ways to improve digestion of this waste stream. The wastewater treatment field is gradually moving toward using food waste as a biofuel feed stock—in this case, pre-consumer food waste such as from dairies, bakeries, or breweries—which are all much more energy rich than municipal wastewater. When these waste products are combined with the wastewater solids in the digester, the

plant can produce increasing quantities of methane gas as a valuable energy source.

## The Design Solution

The team considered one alternative for the Water Environment Association of Utah (WEAU) competition, and thereafter added 4 more alternatives. One of them turned out to be the best option for the treatment plant. The plant is currently building a food waste handling facility and is planning to implement one of the alternatives suggested by the students. Design team leader Dominique Bertrand said they were able to increase the amount of biogas that is produced in two ways:

- Increasing the available capacity of the digestion system by reconfiguring and upgrading the digestion equipment, and



**280,000** gallons/day  
of food waste  
could be directly converted into  
biofuel and energy, generating  
additional annual revenue of  
**~\$600,000**

Story photos by the student design team

## USU's WEAU Student Design Team

- **Civil Engineering:** Dominique Bertrand, Jade Snyder, Ben Sandberg
- **Environmental Engineering:** Hyrum Tennant, Avery Holyoak, Todd Keniry
- **Faculty Advisor:** Dr. Ryan Dupont

# Awards & Achievements

- Increasing the volume of food waste the facility accepts per day.

Dr. Dupont says the students predict that 280,000 gallons a day of food waste could be directly converted into methane and then into power. The students estimated they could generate around \$600,000 of annual revenue from selling the excess power back to the grid. Other possibilities include precipitating out struvite (magnesium ammonium phosphate) and selling it as fertilizer.

The USU student team is already preparing for next year's competition. They are developing ways to address nitrogen and phosphorus removal at the North Davis Sewer District Treatment Plant. With these dedicated and innovative students on the case, regardless of the competition's outcome, we all win as they imagine and develop more efficient and environmentally responsible wastewater treatment approaches. ■

## Below are a few significant achievements at the UWRL in FY2018:

- ▶ Dr. Jeffery Horsburgh and Dr. Niel Allen were each promoted to the position of Associate Professor with tenure this year.
- ▶ Dr. David Tarboton was named a Fellow of the American Geophysical Union in 2018
- ▶ Dr. David Tarboton and the USU team are project lead on a \$4M collaborative NSF funded water research initiative called HydroShare.
- ▶ Dr. Ryan Dupont is project lead on a \$500K USDA/NIFA funded project documenting human health impacts of exposure to microbial

and chemical hazards in reclaimed wastewater used in urban agriculture.

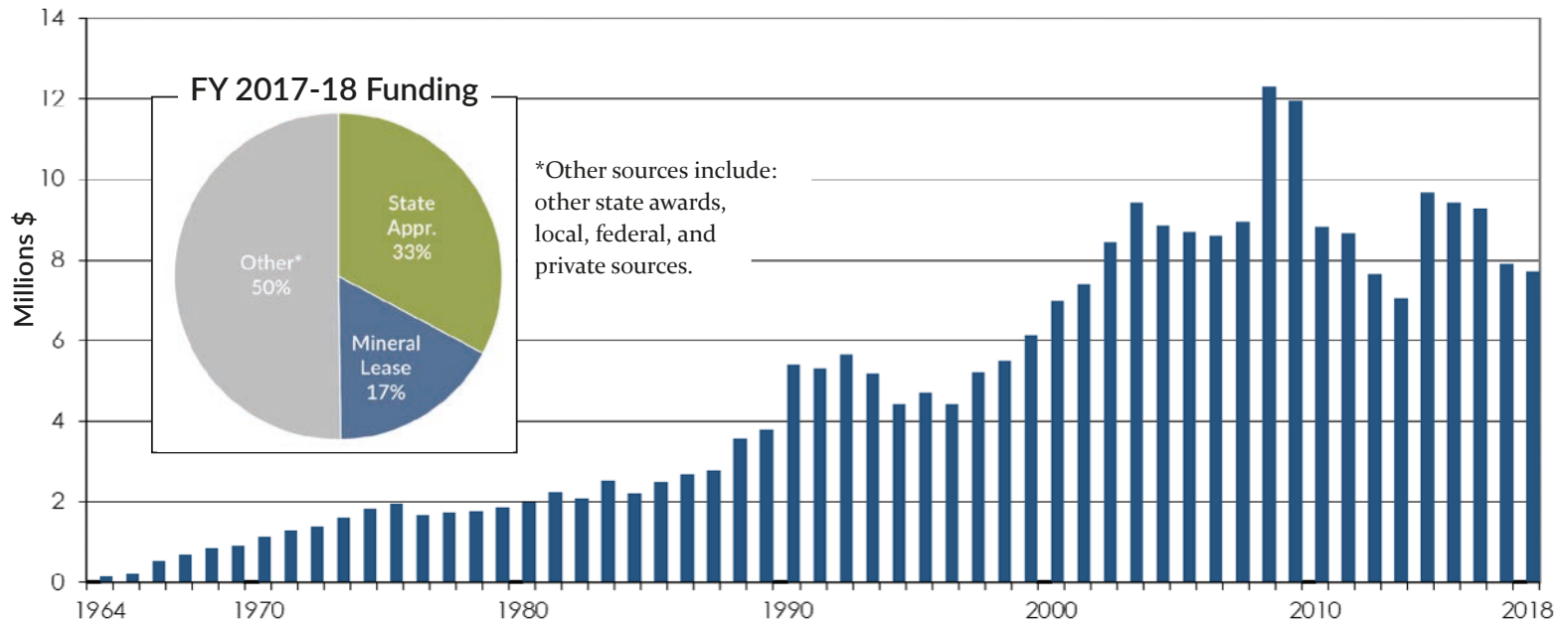
- ▶ Our UWRL Homecoming 2018 event (below) welcomed ~200 alumni, students, faculty, staff, and family members to the UWRL, including several who were here at the lab at its beginning, and some who are just now beginning their time at the UWRL.
- ▶ Civil engineering student Seth Thompson was one of 18 students nationwide to receive a major scholarship from the American Society of Civil Engineers.

...among many others



# FY17-18 Financial/Academic Summary

## UWRL Funding History:



## Research and Training Products:

**251**

Active projects

**126**

Scholarly presentations at professional conferences

**102**

Scholarly publications in peer reviewed journals

**11**

Short courses

## Student Outcomes:

**48**

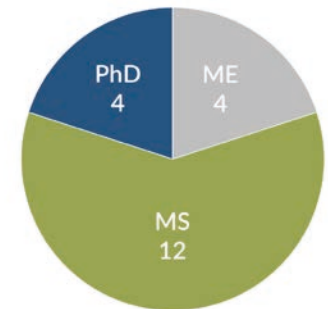
Graduate research assistantships funded

**65**

Undergraduate students supported

**20**

Graduate degrees granted



**\$7,719,954**

Total Annual Expenditures FY 17-18



8200 Old Main Hill, Logan, UT 84322-8200 • (435) 797-3155  
uwrl.receptionist@usu.edu • <http://uwrl.usu.edu>

Publication editor, Carri Richards; Cover photo, Matt Jensen

