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The Water bLog

a newsletter of the

Utah Center for Water Resources Research

at Utah State University

Welcome!

The Water bLog is the semi-annual newsletter of the Utah Center for Water Resources Research (UCWRR), housed at the Utah Water Research Laboratory. The center supports the development of applied research related to water resources problems in Utah and promotes instructional programs that will further the training of water resource scientists and engineers. Each issue of The Water bLog reports on a small selection of the current or recently completed research projects conducted at the center. More information is available online at:

http://uwrl.usu.edu/partnerships/ucwrr

Message from the Director

Mac McKee, Director

Many of the projects underway at the UCWRR address specific water resources problems in the state, but as the saying goes, "we all live downstream." Many of the water challenges we face here in Utah are common to other regions of the country, and likewise, solutions to local challenges can have far reaching benefits for other parts of the state, the nation, and the world.

In this issue of the Water bLog, we highlight two recent projects at the UCWRR that address water resources concerns identified on the Jordan River in Northern Utah. The first project investigates the dangers associated with low-head dams and tests possible renovation strategies to reduce those dangers. The second assesses the causes and extent of water quality challenges in the Jordan River related to stormwater management.

These projects represent only a tiny fraction of the active research ongoing at the UCWRR aimed at finding practical solutions to natural resources problems throughout the state. ■

INSIDE:

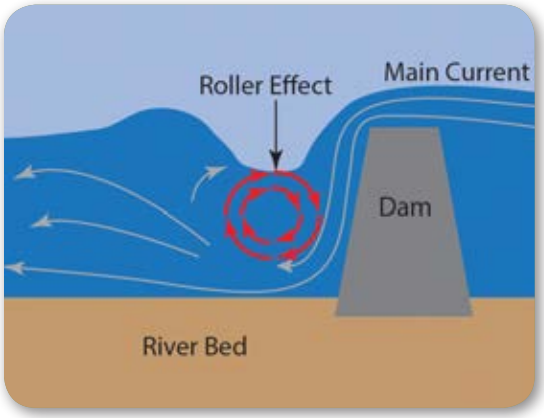
RESEARCH HIGHLIGHT

The Dangers of Low-Head Dams

UCWRR Researchers have been investigating ways to classify the dangers at low-head dams and identify solutions that can be implemented to make these inherently dangerous hydraulic structures safer for the public.

Low-head dams are hydraulic structures, usually no taller than 5 to 10 feet, that are found on many rivers and canals in Utah and throughout the United States. They are designed to impound small volumes of water for irrigation, municipalities, industry, and recreation. They can also be deadly.

Many people drown at low-head dams every year because of a dangerous countercurrent called a "hydraulic" or "roller" that is created as water flows over the dam. In August 2010, two kayakers drowned at a low-head dam on the Jordan River in Murray, Utah.



A dangerous 'roller' current is created as water flows over a low-head dam

UtahStateUniversity

With the hope of making these structures safer for the public, UCWRR researcher Dr. Michael C. Johnson recently led a study of low-head dams that had two goals:

- Establish a classification system for low-head dams based on the dangers created at various flow conditions.
- Identify at least one simple solution that, when added to a low-head dam, would effectively eliminate the danger inherent in these hydraulic structures.

Research

This research used computational fluid dynamics (CFD) software to model flow over 10-ft-tall low-head dams in order to classify the hazards at low-head dams at various flow conditions using easily measurable parameters such as upstream and downstream water depths and dam height.

In addition to the numerical models, physical models of several of the simulations were constructed and tested at the Utah Water Research Laboratory, utilizing a gravity fed rectangular laboratory flume. A scaled human-shaped model with the weight and density of a person wearing a life preserver was placed into the model to test the effectiveness of the remediation options.

Of the nine different configurations tested in the physical model to evaluate their ability to disrupt the dangerous hydraulic and allow the human model to escape, two were effective under most conditions. If the human model remained trapped for more than 50 seconds, the design was considered ineffective. Three variations of the two effective designs were tested.

- The first design consisted of upstream facing ramps spaced along the width of the channel below the low-head dam.
- The second consisted of horizontal platforms spaced along the width of the channel, protruding from the downstream face of the dam slightly below its crest.

Utah's Jordan River is a popular site for water recreation, but it also contains several low-head dams, including the one that claimed the lives of two kayakers in 2010

Benefits to the State

Some important and lasting benefits to Utah include the following:

- Utah and other locations could see a reduction in the number of drowning incidents caused by low-head dams.
- Water-related recreation could be made safer.
- Liability at state-owned dams could be reduced where effective solutions can be implemented.

Looking to the Future

The classification system developed in this study raises public awareness of the potentially deadly flow conditions often found at low-head dams, while the remediation designs offer possible solutions to make these structures safer. If the upstream current can be altered, individuals swept over a low-head dam could continue on downstream with little chance of being trapped by a current.

As awareness of the dangers of low-head dams grows, cities in Utah are looking to redesign existing low-head dams along the Jordan River and other rivers to make them safer. ■

A physical scale model of a flat-topped low-head dam built at the Utah Water Research Laboratory to verify numerical model results and test remediation options

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RESEARCH HIGHLIGHT

Understanding Water Quality Impacts to the Jordan River

Stormwater is a major source of dissolved organic matter (DOM) and oxygen depleting materials that enter the Jordan River during storm events are rapidly produced in stormwater collection systems. Increased stormwater management within the Jordan River watershed is needed to reduce pollutant loading and improve water quality in the river.

The lower Jordan River in Utah is identified as water quality impaired due to low dissolved oxygen, excessive coliform contamination and elevated temperatures. A number of environmental restoration and enhancement projects have been initiated to provide ecological, recreational, and natural, cultural, and historical benefits to the community.

UCWRR researchers are assisting with this effort by providing baseline information to improve understanding of the causes of dissolved oxygen depletion in the Jordan River.

Coarse particulate organic matter and other debris that contributes to dissolved oxygen depletion in the Jordan River

Research

Field sampling and laboratory studies were designed to determine the level and impact of coarse particulate organic material (CPOM) on the production of dissolved organic matter (DOM), the oxygen demand produced by this DOM, and the subsequent oxygen depletion produced within the lower Jordan River.

Samples taken during dry and rainy days quantified base loads versus storm-generated pollutant loading to the river. Sampling of stormwater discharges from Salt Lake City to the Jordan River indicated that:

- Large amounts of CPOM carried with the river are captured and stored in the water column at these discharge locations.
- These solids rapidly decompose and generate significant pulses of highly biodegradable dissolved organic matter, which enters the river during rain events.

Results showed that stormwater from the drainage area between Liberty Lake and the Jordan River is a significant contributor to pollutant loading to the river. Managing pollutant production within the drainage area is essential to protecting the Jordan River from periodic loadings of excessive oxygen depleting materials in the stormwater runoff.

Benefits to the State

This baseline research has documented the significance of stormwater as a source of oxygen depleting materials to the Jordan River and has demonstrated the importance of improved stormwater management and control in improving the quality of the Lower Jordan River.

Stormwater wetland treatment channels can retain the contaminated water to allow for decomposition and uptake of pollutants by wetland plants before the water enters the river

Results have led water quality management efforts to refocus away from the river itself and up into the watersheds and the developed areas draining into the river where more effective and less costly interventions can be implemented.

Looking to the Future

The following are some engineering options that can help manage CPOM-derived oxygen demand:

- Institute lot scale landscape management techniques to reduce CPOM generation.
- Provide more aggressive citywide street sweeping and green waste collection programs to reduce CPOM load to the storm sewers.
- Increase decentralization of stormwater management and implement green infrastructure designed to increase stormwater treatment within the drainage area and decrease the volume of stormwater runoff and associated pollutants centrally collected and transported to the Jordan River. ■

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USU College of Engineering Graduate Student Mentor Award

Dr. Bethany Neilson

Dr. Bethany Neilson was recently named Graduate Student Mentor of the Year for the College of Engineering, Utah State University. This award recognizes faculty with a significant record of cumulative accomplishment focused on graduate mentorship.

Dr. Neilson has mentored 10 graduate students over the past 6 years and takes an active interest in their growth and accomplishments. She has partnered with graduate students on at least 50 conference and professional presentations and 21 peer-reviewed journal articles. All of her students have pursued further education or are currently working as engineering professionals. ■

Second Patent Awarded for Water Salinity Sensor

Dr. Anhong Zhou

In December 2013, Dr. Anhong Zhou was awarded a second patent for his "Lab-on-a-Chip" hand-held salinity ion detector. This sensor can detect and measure salt loading in rivers and track the salinity sources in the water system. He is currently fabricating an integrated DNA biosensor array to detect multiple genotypes of waterborne pathogens. ■

Future Issues

Research Highlights:

"Mitigating Salinity Impacts in the Sevier River Basin" (UCWRR researcher Jagath Kaluarachchi is assessing the cost effectiveness of salinity reduction efforts in the basin)

"Release of Arsenic from Aquifer Solids under Anaerobic Conditions"
(UCWRR research Joan E. McLean is investigating conditions that lead to arsenic release to groundwater in the Cache Valley basin)

Faculty and Student Excellence at the AGU Fall Meeting

December 9-13, 2013, San Francisco, CA

The American Geophysical Union (AGU) Fall Meeting is the largest worldwide conference on geophysical sciences. More than 22,000 earth and space scientists, educators, students, and other leaders attend the conference to present research and meet with colleagues.

UCWRR faculty and students made an excellent showing this year: 4 oral presentations and 7 posters were selected for presentation at the conference.

Jeff S. Horsburgh

Dr. Jeff S. Horsburgh, UCWRR faculty member, was an invited speaker at AGU this year on "Extending the Interoperability of Sensor and Sample Based Earth Observations using a Community Information Model." Dr. Horsburgh's work has contributed to advances in the cyberinfrastructure available for hydrologic and environmental observatories. ■

Noah A. Schmadel

Noah M. Schmadel, a graduate student in Civil and Environmental Engineering, received an Outstanding Student Paper Award for his AGU presentation, "The role of spatially variable stream hydraulics in reach scale, one-dimensional solute predictions."

Only the top 3-5% of student presenters in each focus area receive this honor. Noah is the second UCWRR-affiliated student in the past two years to receive it. ■

Student Visitors from Germany

Dr. Blake Tullis recently hosted Dr. Daniel Bung and Dr. Mario Oertela from Germany, along with a group of their students, on a tour of the Utah Water Research Laboratory (UWRL) and some of Utah's hydraulic structures. The group is pictured here on a physical scale model of an arced labyrinth weir at the UWRL. Dr. Tullis is well-known around the world for his work on labyrinth weirs. ■

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