Conservation the Idaho Way

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Clean Water Machine onsite at the North Alkali Drain near Parma

UNIVERSITY OF IDAHO'S CLEAN WATER MACHINE CHARTS *NEW WATERS*

By Steve Stuebner

It's been a pretty amazing journey for a brainy team of science professors from the University of Idaho who have been competing for a $10 million international prize with their Clean Water Machine.

The team, led by Gregory Moller, a UI professor of environmental chemistry and toxicology, is now among four finalists vying for this clean water science prize. They're competing against teams from China, the Netherlands and another team from the U.S.

The Commission thought it would be interesting to learn more about the Clean Water Machine to see if it might have application at a state or local level to help clean up surface or ground water in Idaho. After speaking with Moller, it turns out that the Clean Water Machine is not their first rodeo … the water-purification technology they invented has been transferred to the private sector, and it's gone global.

Moller and his team have been working on developing innovative, low-cost water-filtration processes to reduce phosphorus, heavy metals and other surface water constituents for at least 20 years. He partnered with Dan Strawn, a UI professor of environmental soil chemistry, to develop their first reactive-filtration system in the first decade of the 2000s. The duo worked with the City of Hayden to perfect their system in a $1 million wastewater research facility, treating 500,000 gallons a day.

"That project proved to be very successful," Moller said. "It was a unique opportunity to demonstrate our technology at a community scale."

Over the last two decades, Moller and Strawn have taken research trials at a pilot scale and worked with the private sector on multiple occasions to export their research to an industry-wide scale. All of that experience seemed to prepare them perfectly for the international competition, the George Barley Water Prize, sponsored by the Everglades Foundation.

"Freshwater is the world's most endangered resource," the foundation says on their web site. "Ninety percent of all drinking water comes from freshwater sources. More than 15,000 water bodies in the United States are in peril because of nutrient pollution. Algae blooms caused by nutrient pollution are estimated to cost the U.S. economy between $2.2 billion and $4.6 billion annually. Removing even a small fraction of the damaging phosphorus pollution using existing technology would cost more than $3 trillion worldwide."

Treated water at 10 ppb is very clean … the champagne glass shows water before and after treatment. (Courtesy U of I)

Algae blooms are not only a serious threat to water quality, they also can cause disease and be deadly to animals and human life, Moller says. "They are a significant disease risk, and some algae blooms can be very toxic."

He mentioned an example of a dog dying in a Washington state park recently after playing in a lake that was known to have algae blooms. The dog owner also had to be hospitalized. "This is a clear and present danger that we need to cope with as a society," he says.

Many of the surface water challenges in Idaho involve removing phosphorus and other constituents through TMDL processes or installing best management practices in the field.

Martin Baker, a mechanical engineer, rounds out the Clean Water Machine team. "Martin was raised on a Jerome dairy farm. He's our lead integration engineer," Moller says. "He really drills down on how we can integrate our research into real-world solutions. "He's an extraordinary talent who helps us turn our dreams into reality."

The Clean Water Machine was brought to the North Alkali Drain last summer near Parma to work on cleaning up irrigation return flows with high levels of phosphorus. The machine reduced phosphorus levels to below 10 parts per billion, a very high clean water standard. The Clean Water Machine has shown similar results in the international competition at the Holland Marsh in Ontario, Canada, and in the Florida Everglades.

"We are pushing the limits" of pollution-reduction, Moller said. "There's a global need for that."

Their work has been featured multiple times on national news, including NBC-TV. Similar to computer technology pioneers who started their innovations in a garage of a private home, Moller and his team started with a kernel of an idea, and their quest for clean water solutions drove them to perfect the technology they're using and sharing with industry and society today at a much larger scale.

"We've had an impact on providing clean water for more than 2 million people in North America and the United Kingdom, treating billions of gallons of water each year – all starting from humble origins in Moscow, Idaho," Moller says.

University of Idaho officials are proud of the team's success.

"Nothing is more critical to sustaining agriculture and the environment than developing technologies to improve water quality," said Michael Parrella, Dean of the UI College of Agriculture and Life Sciences. "Finding ways to prevent and recover phosphorus and nitrogen from entering streams and lakes will help us maintain food production and protect ecosystem services that we have all come to expect from our waterways.

"The demonstration of the Clean Water Machine at the North Alkali Drain near Parma proves that it may be part of the solution going forward," Parrella continues. "Its ability to extract phosphorus is unparalleled and has already won international acclaim. It was good to see it in operation in an important agricultural area in the state."

Moller describes the Clean Water Machine as a "Swiss Army knife for water sustainability." The economics of water treatment will play a role as to whether the technology is cost-effective on a larger scale, he said, noting that they are always thinking about keeping costs down and looking for ways to transfer research for broader use in society.

How did they get started?

Initially, Moller found himself perplexed by the amount of attention focused on water quality issues and problems in the late 1990s and early 2000s. "I found that I wanted to shift my focus to configuring solutions rather than dwelling on the problems," he said. "That was a broad challenge to me, personally."

Clean Water Machine team looks at the impact of adding biochar to water treatment. From left, professor Dan Strawn, Liam Knudsen and mechanical engineer Martin Baker (courtesy U of I)

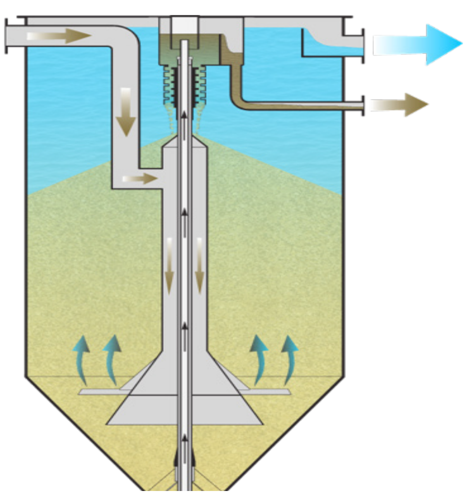
He noted that water pollution can happen quite readily, from point sources, hazardous waste, agricultural non-point pollution and more. When those contaminants are introduced to a river, stream or lake, they can spread quite rapidly due to the mobility of water and the volume.

"It's easy to pollute, but it's very expensive to fix those problems," he notes.

In general, back in the day, many water issues could be fixed under the mantra of "dilution is the solution to pollution," he said. But there are some harmful constituents that end up in wastewater plants and surface water that can cause long-term harm to fish and aquatic life – things like hormones, antibiotics and heavy metals.

Moller started researching existing treatment solutions, and thought about working on a simpler, more natural process. "I focused on going back to nature – using nature as an inspiration," he says.

In essence, in nature, say a forest watershed, it's the soil that filters and cleans water before it runs off in the stream. He reached out to fellow faculty member Dan Strawn, a soil chemist, and they began to think about novel solutions through the use of a "reactive-filtration" method, the same method they're using in the Clean Water Machine today.



A continuous upflow sand filter

"How can we make it efficient?" he wondered. "How can we make it low-cost? How can it help upstream and downstream users?"

He wanted to engineer a reliable solution – something that might be as dependable as flipping on a light switch as we take for granted today with an electric grid powering society.

In the mid-2000s, Moller and Strawn discovered that introducing iron to a sand filter, combined with water and air, could filter out phosphorus. Strawn's knowledge of molecules and microbes helped immensely, Moller said.

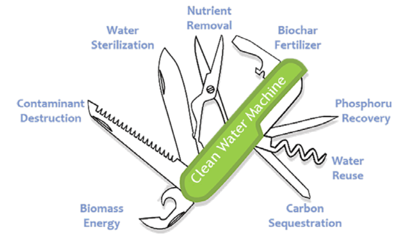
"You inject the dirtiest water into the bottom of the filter, and we stained the sand at the top of the sand layer with iron oxides to turn it reddish-orange, and the iron did the trick," he said. "That was the new thing … adding iron to the water in contact with sand."

The iron-coated sand grains also scrub the water clean, he says, while the water continuously flows through the sand. "It's kind of like a flour grinder."

They licensed that technology in 2004, and as mentioned before, they perfected the reactive filtration process with the City of Hayden. A new startup company, now a part of Nexom, was formed at the time to take the new technology to the wastewater industry at a broader level. The company now operates in North America, with offices in Post Falls, Milwaukee and Winnipeg, Canada.

Moller chose to stay in the university setting despite the patents and notoriety he has received for the new technology. "The motivation for financial gain is not as high as doing something good for society," he says.

Moller has received six patents for the water-filtration work, and three more are pending. He has received multiple awards for his work, including an



The Machine is the Swiss Army knife of clean water projects

induction into the National Academy of Inventors as a fellow, and an Eddy Medal from the Water Environment and Reuse Association.

Florida Everglades aspect of the competition

In the Florida Everglades, the challenge for the George Barley contest was to remove phosphorus levels in surface water from 57,000 acres of highly engineered wetlands. About 2,100 miles of canals, 2,000 miles of levees and berms, 600-plus water control structures, 620 culverts, and 77 pump stations serve the wetlands complex.

Known as the Everglades Region Storm Water Treatment Areas (STAs), they can remove phosphorus from surface water at a "substantial land-footprint cost," a paper presented by Moller on the Clean Water Machine treatment said. More substantial reduction in phosphorus levels are needed at a lower cost, he said.

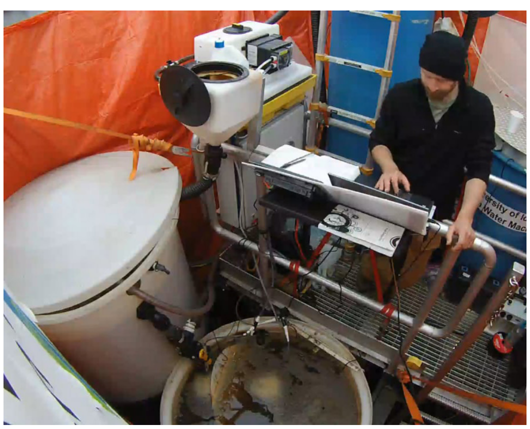
The UI team has also designed the Clean Water Machine in a "ChannelBox" (inside 40-foot mobile shipping containers) with their trademark reactive-filtration method. The airlift sand filters can treat 4,000 cubic meters of water or 1 million gallons of water per day. "The ChannelBox design could be set up into a water channel or adjacent to it," Moller said. The goal is to purify water to 10 parts per billion total phosphorus.

The amount of water treated for the Everglades portion of the competition was equivalent to a wastewater system that serves about 10,000 people. Hence, their approach may have application for a standard municipal wastewater treatment system, he said.

To compete in the finals of the George Barley contest, the UI team would have to scale-up to treating 1 million gallons of water per day. By comparison, the city of Moscow's wastewater treatment plan treats 2 million gallons per day. The team, including their industry licensee, is still pondering as to whether it can commit to spending 14-15 months and approximately $2 million to build a Clean Water Machine at the larger scale.

"That's a considerable investment, but we're still exploring that," he says. "The window is still open. We are genuinely gratified to be an international finalist."

Asked his opinion about looking at reducing phosphorus in Idaho's surface water systems, Moller said he recommends looking at a "whole system architecture," or a holistic approach at a watershed scale.



Inside the Machine

He commends Idaho farmers and soil and water conservation districts for working to reduce sediment runoff and phosphorus loads through best management practices, sediment basins, and filtration systems. He also recommends taking care to ensure that fertilizers reach plants in the root zone and stays there. Sediment traps and basins are a good way to preserve topsoil and reapply it to fields, he says.

It hasn't been cost-effective to actually treat surface water in something like a Clean Water Machine before it flows into a major river system in Idaho, but the city of Boise is experimenting with the Dixie Drain near Parma as one method of reducing phosphorus loads in the Boise River. Down the road, site-specific treatment may be needed.

"From north to south in the state, there is large variation in water availability as we generally go from non-irrigated to irrigated agriculture, respectively," Parrella says. "Regardless of where you are in Idaho, clean water matters. And while agriculture is the major user of both surface and ground water in the state, city dwellers and rural residents also pose a threat to water quality. Agriculture, the environment and the citizens of Idaho all must have clean water sources.

"The ultimate question is how do we collectively maintain Idaho's valuable water resources so that there are sufficient supplies, and these supplies are clean enough to satisfy multiple uses? Greg Moller, Dan Strawn, Martin Baker and many other researchers at UI's College of Agricultural and Life Sciences are doing their best

Team leader Greg Moller favors a broad systems-based approach to addressing phosphorus in surface water

to provide the most useful answers in the short and long term."

"We're all trying to move the ball down the field," Moller adds. ❑

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