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RECLAMATION

Knowledge Stream

Research and Development Office

Prize Competitions



Research and Development Office (R&D) Contacts

Program Manager
Ken Nowak
knowak@usbr.gov

Science and Technology Program Coordinator
Eve Halper
ehalper@usbr.gov

Desalination and Water Purification Research Program Administrator & Water Treatment Research Coordinator
Andrew Tiffenbach
atiffenbach@usbr.gov

Analyst Engineer
Lauren Dennis
ldennis@usbr.gov

Hydropower and Water Infrastructure Research Coordinator
Erin Foraker
eforaker@usbr.gov

Water Availability Research Coordinator
Christopher Frans
cfrans@usbr.gov

Prize Competitions Program Administrator
Christine VanZomeran
cvanzomeran@usbr.gov

Open Water Data Coordinator
Allison Odell
aodell@usbr.gov

Budget Analyst
Cristina Davila-Ruiz
cdavilaruiz@usbr.gov

Administrative Assistant
Lisa Harper
lharper@usbr.gov

GIS Program Coordinator
Lisa Johnson
lisajohnson@usbr.gov

Associate Chief Data Officer
Jeff Nettleton
jnettleton@usbr.gov

Data Resource Manager
James Nagode
jbnagode@usbr.gov

Message from R&D

Welcome to the Summer 2024 issue of the *Knowledge Stream*! In this issue, we highlight the Bureau of Reclamation's (Reclamation) Research and Development Office (R&D) Science and Technology (S&T) Prize Competition Program.

The Prize Competition Program is an innovative crowdsourcing tool to address Reclamation's toughest water and power management research gaps. Reclamation has launched 34 competitions and awarded over \$6.5M for winning solutions since the inception of the Prize Competition Program in FY 2015. In FY 2023, the Facilitated Adoption program was created to move promising Prize Competition solutions into practice. The Prize Competition Program partners with Federal and non-Federal partners to leverage and combine resources to jointly address common objectives. The R&D Office, recognizing the innovation potential of Prize Competitions, continues to support and broaden S&T opportunities to meet Reclamation's mission.

Topics included in this issue are:

- What's new in the Prize Competition Program
- Recently completed, on-going, and upcoming prize competitions and technology searches
- The first facilitated adoption project to move a Prize Competition solution to demonstration
- How you get involved with Prize Competition Program

About the *Knowledge Stream*

The *Knowledge Stream*, published by the Bureau of Reclamation's Research and Development Office, is a quarterly magazine bringing mission-critical news about the agency's innovations in the following:

- Science and Technology Program
- Desalination and Water Purification Research Program
- Prize Competitions Program
- Snow Water Supply Forecast Program
- Open Water Data Program
- Reclamation Geographic Information System Program
- Technology Transfer...and more

Content Lead

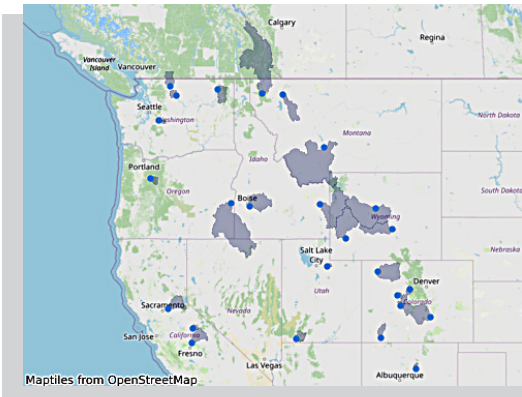
Contact

Christine VanZomerén
cvanzomerén@usbr.gov

More Information

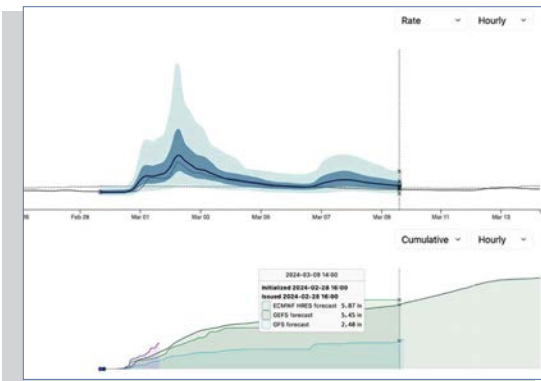
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For more information on articles within this issue, please contact the listed author or Christine VanZomerén.



Water Supply Forecast Rodeo

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Facilitated Adoption of Streamflow Forecast Rodeo Solution

pg. 17

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Front Cover: Image of AqualInject, Where IoT Meets Vegetation Control system.

Back Cover: Collage of photos from different prize challenges.

The information being offered herein represents the opinion of the author(s) and is not a statement of fact about Bureau of Reclamation findings or conclusions.

Community Needs

Innovative Solutions for Reclamation’s Toughest Problems

By **Christine VanZomerén**
 cvanzomerén@usbr.gov

There continues to be significant growth in the prize competition space since Reclamation’s Prize Competitions Program began in FY 2014, receiving appropriations for the first time in FY 2015. This Knowledge Stream highlights areas of growth within the Prize Competition Program, including two new complementary tools and mechanisms: technology searches and facilitated adoption. Prize competitions remain a key tool to spur innovation through crowdsourcing to address some of the most challenging water and power management gaps facing Reclamation and its stakeholders.

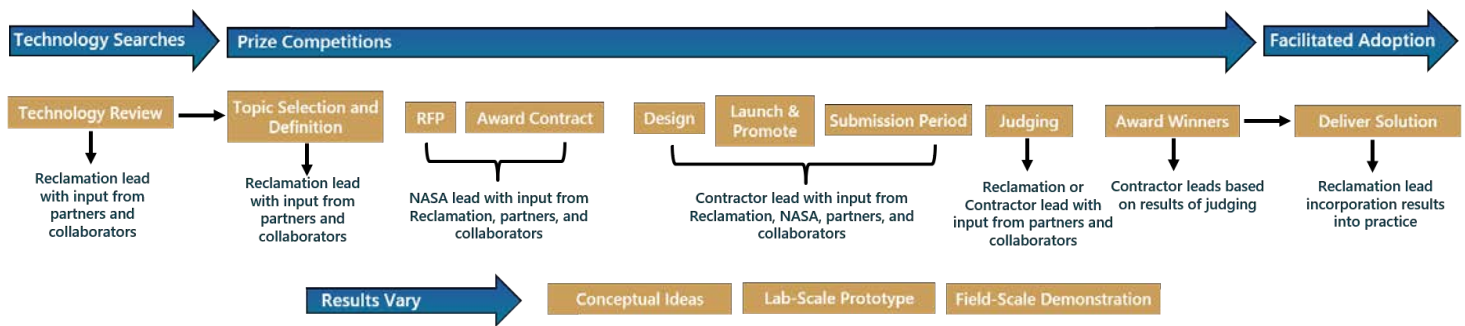


Figure 1. Science and Technology Program process through technology searches, prize competitions, and facilitated adoption.

At the center of successful prize competitions and technology searches is National Aeronautics and Space Administration’s (NASA) Center of Excellence for Collaborative Innovation (CoECI), facilitated by the NASA Tournament Lab. NASA CoECI assists federal agencies in the use of crowdsourced challenges to solve mission-critical topics. Reclamation’s prize team engages with NASA CoECI to develop prize competition requirements and select a contractor. The contractor, in collaboration with CoECI, works with Reclamation on all parts of technology searches or prize competitions. While NASA does not support the execution of the facilitated adoption program directly, the success of prize competitions run through NASA sets up the opportunity for successful facilitated adoption projects.

Prize competitions can address tough problems where solutions have been evasive or expensive to implement. Topic selection and scope boundaries are identified through Prize Theme Area Leads, subject matter experts in the field, and collaborative efforts. Framing the problem, solution requirements, and capturing the current available solution landscape on that topic is crucial to designing a successful prize competition. In 2020, technology searches were identified as an additional tool to complement traditional formats to help define the problem and solution boundaries for prize competitions shown in figure above. Because of this, technology searches are often the precursor for a prize competition.

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Prize competitions spur innovation by engaging a non-traditional solver community.

Equally as important as scoping and defining prize competitions is the implementation of prize competition solutions into practices. In 2023, the Science and Technology Facilitated Adoption program was introduced to accelerate the incorporation of prize competition solutions to benefit water and power managers. Facilitated Adoption furthers a prize competition solution by demonstrating the use of the results or transferring the knowledge from a prize solution into practice. To that end, facilitated adoption furthers the objective to implement promising prize competition solutions to meet Reclamation’s mission.

Prize competitions are a unique tool in the toolbox to spur innovation and expand potential solutions by tapping new solver spaces. Prize Competitions can jump start research, move technology forward at a quicker pace, and initiate creative solutions to tough scientific and technical problems. Prize competitions, in concert with technology search opportunities and the facilitate adoption program, address Reclamations most difficult technology challenges Reclamation faces.

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Technology searches define the solution landscape often through electronic surveys and expert interviews. Electronic surveys obtain insights from targeted experts to rapidly identify potential industry partners. Expert interviews are targeted discussions with subject matter experts (SME) to rapidly gather insights on the selected topic. Topic selection and design for prize competitions benefit from technology searches because we understand the complete landscape and identify key gaps that prize competitions can address. Technology searches also address a solution directly if a previously unknown technology is found and fits the solution criteria. If there is not a solution identified that meets the criteria, a topic will move from a technology search to a prize competition to address the identified need.

The prize competition process is multi-step to select topics, design and judge a competition, and award winners for innovative solutions (see figure 1). Prize competitions are inherently flexible in topic identification, design structure, deliverables, and prize purse amounts; each prize competition is unique to fit the needs of that particular topic and solution. For example, prize competitions can be single stage or larger multi-staged competitions. Deliverables can be conceptual ideas or designs, lab scale prototypes, or field scale demonstrations, or combinations of these deliverables (see figure 1).

Competitions can complement traditional research and target Reclamation’s most persistent science and technology challenges.

Getting Involved in Prize Competitions

By **Christine VanZomeran**
cvanzomeran@usbr.gov

How do you get involved in a prize competition? Prize competitions involve the participation of a team of subject matter experts (SME) with a diverse set of skills, regardless of scope and size of the technology search or prize competition. These experts serve as part of the design team, team members, and judges, and are essential to the success of a prize challenge. They may include other Federal agencies, state agencies, municipalities, non-profit organizations, or private sector partners. SME recruitment from multiple Federal agencies and non-Federal organizations that have a stake in the problem landscape helps to accurately define the problem,

current solutions, the performance metrics sought in a successful solution, and provides diverse insights during the judging process. SMEs can be involved throughout the prize challenge life cycle or participate in particular phases depending on subject matter expertise needs. Some SME team members will join the team at the initiation of the design process; others will join the team as the project scope and expertise that is needed becomes better defined. SME team members participate as a judge in one or more phases of a prize competition. They are also needed for topic selection and evaluation of potential solutions identified through technology searches.

What else can SMEs contribute to a prize competition?

- Topic/issue identification
- Technical support to solvers
- Field or facility locations for demonstration
- Test/mature solutions
- Amplification of competition through outreach and marketings
- License and commercialize winning solutions
- Monetary or non-monetary recognitions/contributions

What's the benefit of Federal and non-Federal participation in Reclamation prize competitions? Partnering leverages and combines resources to increase cost effectiveness and maximize return on taxpayer dollars, increases the chances of successful solutions with shared common objectives, can make significant changes to the benefit of the public, and moves forward the missions of partnered agencies or organizations.

Competitions use prizes to incentivize solvers to submit solutions and are open to a solver community that includes members of the public, businesses, and other organizations.

Identified a tough problem prize competitions can advance?

Contact prize@usbr.gov

Key Perspectives

What's New with Prize Competitions, Technology Searches, and Facilitated Adoption

By **Christine VanZomeran**

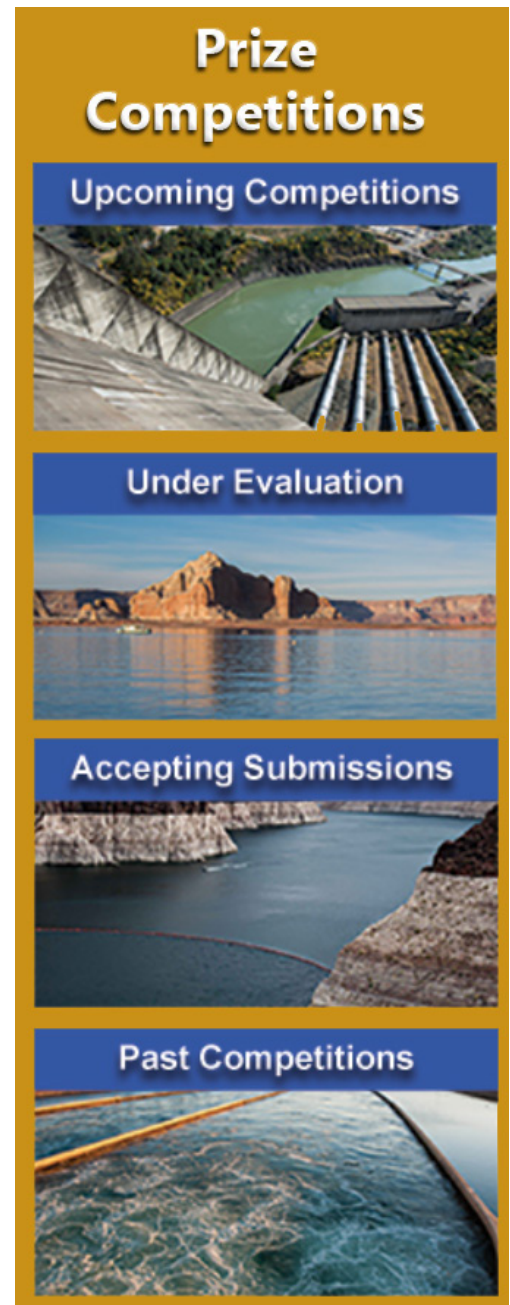
cvanzomeran@usbr.gov

Recently completed, on-going, and potential new topics address three theme areas critical to Reclamation's mission: water availability, infrastructure sustainability, and the environment. The water availability theme area helps water managers facing current and future water demands from agriculture, municipal, industrial, Tribal Nations, rural, recreation, power generation, and ecosystem needs. The infrastructure sustainability theme area supports safe, well-maintained, and reliable inventory of dams, pipelines, hydropower generation facilities, canals, and levees. The environment theme area supports operations to ensure watersheds are healthy, continue producing water, and supports compliance with State and Federal laws requiring protections of aquatic species.

Since 2014, Reclamation has completed 34 prize competitions, awarding over \$6.5M for winning solutions. In addition, 18 technology searches have been completed or are on-going since 2020. The following articles describe recently completed, on-going, and potential new prize competitions and technology searches. One prize competition, Imperfection Detection, was completed at the end of FY 2023 and are three on-going prize challenges, Veg Out– Managing Aquatic Vegetation in Canals, Counting Every Drop, and Water Supply Forecast Rodeo. Current technology searches are Sealing Large Conduits During Uncontrolled Releases, Detecting Subsurface Cracks in Embankments, and At-Rest Soil Stress. The Streamflow Forecast Rodeo Prize Competition, completed in FY 2022, is highlighted as the first example of a prize competition solution continuing onto a facilitated adoption.

As on-going technology searches and prize competitions come to completion, new topics ripe for technology searches and prize competitions are being developed. It is a continual and iterative process to explore new topics, identify appropriate path forward, and identify opportunities for partnerships and collaboration. Potential new topics of interest are also described in this *Knowledge Stream*.

The following articles are arranged in the natural progression of maturing a topic: scoping a topic with technology searches, developing a prize competition, and delivering a solution into practice with facilitated adoption. Recently completed technology searches are described and highlight the value of technology searches in identifying available and in development technology, and gaps in selected topics. Three on-going prize challenges are described, as well as a recently completed prize challenge. Finally, the first prize solution to move to facilitated adoption is highlighted in this *Knowledge Stream*.



Visit www.usbr.gov/research/challenges/index.html to stay informed on past, current, and upcoming prize competitions.

Identifying Topics with Technology Searches

Sealing Large Conduits During Uncontrolled Releases Technology Search

By **Bobbi Jo Merten, Ph.D.**

bmertent@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA), Maven Research, Inc.

Reclamation sought technologies for emergency closure of conduits during uncontrolled water releases. An uncontrolled release occurs when a failure of the gate regulating the flow of water occurs. Innovative solutions could help operating facilities stop a free-flowing release due to the gate failure. The goal of this technology search was to identify a safe and reliable solution that can be quickly deployed without the use of a diver, thus limiting water loss and flooding downstream. This technology search was completed in April 2024 and resulted in several engineering design concepts. A next step is to evaluate scale models of the design concepts in the laboratory and determine the applicability to a variety of Reclamation structures that could benefit from this engineering solution.



Conceptual engineering solution that applies a sealing plate to the conduit opening using a crane and support from autonomous or remotely operated vehicles as needed.

Detecting Subsurface Cracks in Embankments

Technology Search

By Evan Lindenbach

elindenbach@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA), Yet2

Reclamation sought technologies for detecting subsurface cracks in earthen embankment dams. As an embankment is constructed, differential settlement along the dam profile may cause cracking through the embankment, which can lead to internal erosion. Having a tool to investigate an embankment where cracks may exist is beneficial for designers and for use in a potential failure mode analysis. The goal of this technology search was to identify potential existing technologies that can detect subsurface cracks. The technology search identified solutions from ground penetrating radar and

electric resistivity tomography to quantum sensors and fiber optics. The range of potential solutions was broad, and the team found intriguing tools that may be of use for other structural health monitoring applications. The technology search was completed in April 2024 and provided several interesting technologies to explore further; however, did not identify a technology that fully addressed Reclamation's specific need. The next step is to meet with other potentially interested government agencies and start scoping a prize competition to locate embankment cracks.

At-Rest Soil Stress Technology Search

By Evan Lindenbach

elindenbach@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA), Yet2, U.S. Army Engineer Research and Development Center (ERDC)

Reclamation, in collaboration with ERDC, sought technologies to measure the lateral soil pressure exerted on a vertical surface. Understanding the at-rest lateral earth pressure is a key design element for civil engineering designs such as slope stability, pile foundations, hydraulic fracturing of embankment dams, and earth retaining structures such as spillway walls. The goal of this technology search was to identify potential technologies that can detect subsurface cracks without soil disturbance to reduce risk and address issues with existing

dams, and improve design for new dams. This technology search was completed in May 2024 and identified a number of potential solutions ranging from fiber optic and tactile sensors to robots and other contactless measurements. The technology search has even identified interesting medical devices that may be useful for the laboratory or field scale. The planned next step is to start scoping a prize competition with the technology search team to further a solution that addresses Reclamation's need.

On-going and Completed Prize Competitions

Counting Every Drop Prize Challenge

By **Lindsay Bearup & Ian Ferguson**

lbearup@usbr.gov, iferguson@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA), USDS Natural Resource Conservation Service, Freelancer

Precipitation—including rain, snow, sleet, and hail—is the primary driver of the hydrologic cycle. Precipitation drives runoff and infiltration, which in turn drive the streamflow and groundwater recharge that determine surface water and groundwater supplies, respectively. Scientists rely on accurate and reliable measurements of precipitation to understand and characterize the hydrologic cycle and its relationship to climate, landscapes, and ecosystems. Reclamation and other water management agencies similarly rely on precipitation measurements to monitor basin conditions and support streamflow, water supply, and flood forecasts, among other purposes. These forecasts are used to inform water management decisions ranging from water allocation to flood control to environmental restoration.

Federal and state agencies, irrigation districts, municipal water providers, and private citizens measure rain and snowfall across the Western United States using a variety of devices and methods. The simplest device is the Standard Rain Gauge, which consists of a funnel, measuring tube, and a measuring stick. Precipitation is collected through the funnel into the measuring tube and is measured manually with the measuring stick, typically on a daily basis. Storage and weighing gauges similarly use a funnel to collect precipitation into a storage reservoir, but precipitation is measured using a pressure transducer or load cell. Tipping bucket gauges funnel precipitation to rocker mechanism with two small buckets located at each end; when one bucket fills, the rocker tips and the other bucket moves beneath the funnel. A sensor counts the number of tips to determine the amount of precipitation. Storage, weighing, and tipping bucket gauges can be automated to measure precipitation at remote monitoring sites.

While existing precipitation gauges work reasonably well, these devices have significant operation and maintenance (O&M) challenges as well as known limitations in measurement accuracy and stability. In particular, existing gauges struggle to measure solid precipitation (i.e., snow, sleet, and hail). Storage and weighing gauges rely on antifreeze fluid to melt solid precipitation while tipping bucket gauges rely on electric heating mechanisms to melt solid precipitation so that the liquid precipitation can be measured. Antifreeze fluid needs to be restocked annually, which poses a significant O&M challenge, particularly for gauges located in remote mountain headwaters. Similarly, the power required to heat tipping bucket gauges exceeds the power supply available at most remote monitoring sites.

These O&M challenges along with imitations in the accuracy and reliability of existing gauges led Reclamation to partner with the U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS), NASA Tournament Laboratory, and Freelancer to launch the Counting Every Drop Challenge. This challenge seeks new and innovative precipitation measurement devices that reduce O&M and power requirements while maintaining or improving accuracy and reliability.

The first phase of the Counting Every Drop Challenge launched in August 2022 and tasked competitors with submitting a white paper describing their proposed solution for a precipitation measurement device that addresses the limitations of existing devices. Phase 1 ended in October of 2022 with 32 entries from 30 competitors. Seven winners were selected from the entries.

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COUNTING EVERY DROP CHALLENGE
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	<p>PRIZE: \$80,000 USD total prize purse</p> <p>Counting Every Drop Challenge Phase 1</p> <p>Create a concept paper on your precipitation measurement device.</p>		<p>PRIZE: \$220,000 USD total prize purse</p> <p>Counting Every Drop Challenge Phase 2</p> <p>Incorporate your Phase 1 concept into a prototype ready for field testing by NRCS.</p>
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Each received \$10,000 for their proposed solutions and were asked to submit a prototype for the second phase of the competition.

In Phase 2, three prototypes from winning solutions were submitted and accepted for lab and field testing. In the summer of 2023, the NRCS installed two of the prototypes in Sister, Oregon at a site that could be accessed throughout the winter season for the year of monitoring. These prototypes are still in the field and are encountering many of the elements that challenge traditional precipitation sensors,

including wind and cold temperatures. The third prototype required additional safety review and is now installed at a Reclamation owned site in Boise, Idaho. Monitoring of the three deployed prototypes is ongoing. One winning solution that meets the requirements and doesn't require fluids to operate is eligible for a \$100,000 prize. If there are no fluid-free designs, the prize amounts will be redistributed. All solutions are eligible for a share of the \$30,000 innovation awards. Check out the Freelancer website for more information on the requirements, competitors, and winners of Phase 1.

Managing Aquatic Vegetation in Canals

By **Scott O'Meara & Connie Svoboda**

someara@usbr.gov, csvoboda@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA),

U.S. Army Corps of Engineers – Engineer Research and Development Center, HeroX

The Veg Out prize competition, launched in October 2022, aims to reduce the cost and labor of aquatic vegetation management in canals while minimizing undesirable impacts to water quality or downstream users. The prize competition seeks to identify, develop, and test novel, sustainable, and scalable solutions that can be used across a range of canal types. A total prize purse of \$345,000 will be distributed across three phases of concept, prototyping, and demonstration.

Reclamation's 8,000 miles of canals deliver water across the Western United States, serving over 30 million customers and 10 million acres of farmland. These canals are impacted by aquatic vegetation that can reduce canal capacity, increase operating elevations, degrade water quality, and limit access for canal inspection and maintenance. This prize competition seeks solutions that target rooted aquatic vegetation such as rooted floating (e.g., waterlily, watershield), emergent (e.g., water primrose, purple loosestrife), and submersed (e.g., Eurasian watermilfoil, hydrilla), free-floating vegetation and algae are excluded from the scope of this competition.



Aquatic vegetation in a canal.

Existing methods for managing vegetation (primarily mechanical and chemical) have various drawbacks. Mechanical methods include dredging, chaining, raking, and cutting. While mechanical methods produce immediate results, the process is costly, labor intensive, can disrupt embankments, does not prevent regrowth, and can cause large amounts of debris and sediment to move downstream. Common chemicals currently used in canals for vegetation management include Acrolein, Endothall, Copper, and Glyphosate. Although chemical options can be very effective for vegetation management in some situations, it may not be a viable method due to high exposure times necessary or regulatory restrictions. Chemical management is also temporary and must be conducted on a regular basis which can be costly and potentially present hazards to users or cause detrimental downstream effects.



Facility impacts of aquatic vegetation.

Reclamation is seeking solutions that can effectively reduce biomass of rooted aquatic vegetation by at least 70 percent compared to existing conditions while not causing harm to agricultural plants or non-target organisms. The canal cannot be altered or damaged and canal operations cannot be restricted or impeded. Solutions must be cost-effective and able to be implemented on a large scale.

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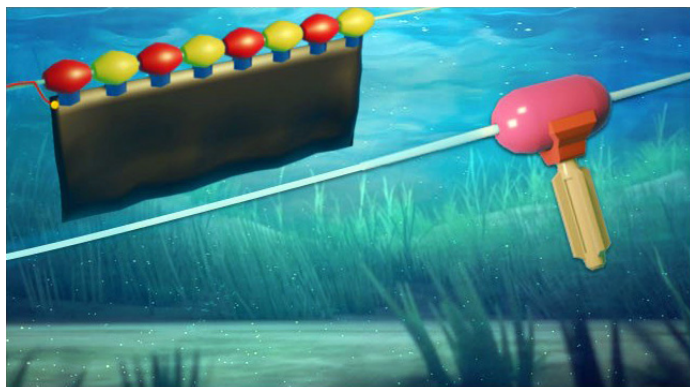
In March 2023, Reclamation announced that the following Phase 1 winners would share in a \$160,000 prize pool for their concept submissions and move on to prototyping in Phase 2.

- AquaInject, Where IoT Meets Vegetation Control, Trent Lewis



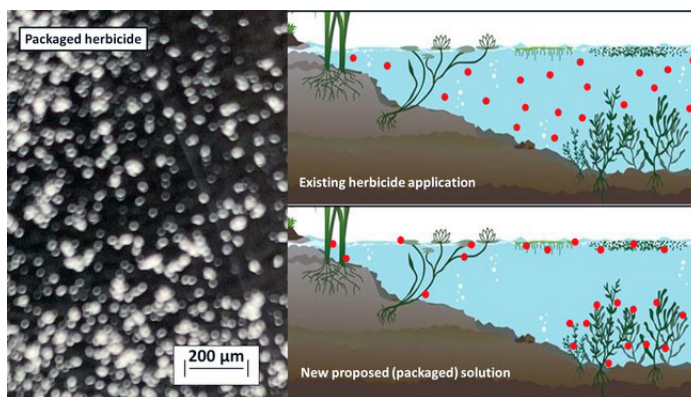
AquaInject, Where IoT Meets Vegetation Control system.

- Electric Macrophytes Management Solution, Shawn Kozak



Electric Macrophytes Management Solution.

- Packaged Herbicides for More Efficient Control, Jan Beetge



Packaged Herbicides for More Efficient Control.

The following honorable mentions were commended for their excellent innovative submissions:

- Directed Energy Aquatic Defoliation-DEAD, Jonathan Jackson
- Genilec, Large Coverage Robotic Solution, Vincent Leroux

Over a nine-month period, Veg Out winning solvers worked to develop and prototype their concepts and perform small-scale testing of their solutions with limited technical support from Reclamation subject matter experts. Reclamation announced in March 2024 that all three winning teams met the criteria to advance to Phase 3 – Proof-of-Concept Demonstration. In addition, the Genilec team was provided with an honorable mention, but did not advance to the final phase.

In Phase 3, each team will demonstrate their technology in a representative location such as a canal, laboratory, or other controlled environment. A live demonstration and recorded data will showcase the ability of the solution to manage vegetation in an effective, safe, and scalable manner. The multi-agency judging panel will select a first-place winner and runner-up in October 2024. In addition to a financial award, the first-place winner will have the opportunity to work with Reclamation to further field-test their solution in a canal.

Water Supply Forecast Rodeo

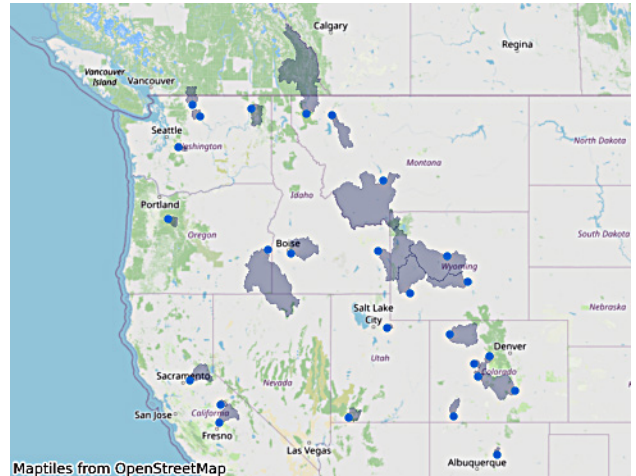
By Lindsay Bearup & Ian Ferguson

lbearup@usbr.gov, iferguson@usbr.gov
 Partner(s): National Aeronautics and Space Administration (NASA),
 USDS Natural Resource Conservation Service,
 National Oceanic and Atmospheric Administration (NOAA), DrivenData

Seasonal water supply forecasts provide a prediction of total cumulative streamflow volume over a specified time period and a specified location, such as a Reclamation reservoir. The forecast season of interest varies by location but typically covers the spring and summer. These forecasts are critical to support water management and safety decisions related to water supply, flood control, hydropower generation, and environmental objectives. Currently, agencies such as the NRCS and NOAA’s River Forecast Centers use a variety of statistical and physically-based models in combination with data describing current watershed conditions and possible future weather. Forecasts have inherent uncertainty, not only from the unknown future weather, but also from the available observation and modeling tools.

The goal of the Water Supply Forecast Rodeo is to develop forecast models that predict naturalized cumulative streamflow volume and address the uncertainty of predictions by providing 0.10, 0.50, and 0.90 quantile forecasts for 26 locations and their relevant forecasts seasons, (commonly April through July). The challenge is ongoing and occurring over multiple stages. The Hindcast Stage ran from October 2023 through January 2024 and evaluated models on historical data simulating real-time forecasting. Winners of the hindcast phase were just announced.

The Forecast Stage began in December 2023 and runs in real-time during the 2024 season, ending in July 2024. After July, forecasts will be evaluated against the true water supply measurements and top leaderboard performers will win Forecast Stage prizes. A final prize stage will ask solvers to submit additional materials for the overall and bonus prizes, like model reports and cross-validation predictions, which will be judged by a panel of technical experts. The final stage also includes prizes for explainability, based on provided information in the final reports that can increase understanding of how predictors drive forecasts and changes in forecasts. For more information on this ongoing challenge, head over to [DrivenData’s competition page](#).



Map of 26 forecast locations used in the Water Supply Forecast Rodeo. Sites are shown as blue points, and drainage basin polygons are shown in gray. (DrivenData)



Releases from Shasta Dam after a wet winter and February 2024 storms. (Reclamation)

Imperfection Detection: Detect Me if You Can

By Bobbi Jo Merten, Ph.D.

bmerten@usbr.gov
 Partner(s): National Aeronautics and Space Administration (NASA), U.S. Army Engineer Research and Development Center, Clemson Composite Center, Jesse Garant Metrology, Thompson Pipe Group, HeroX

The Imperfection Detection prize competition sought portable tools to non-destructively evaluate the condition of fiber reinforced polymer (FRP) composite structures. The challenge was designed to accelerate new solution development and evaluate prototype performance. As existing composite

materials in our water infrastructure age, the implementation of reliable and non-destructive methods is needed to assess the condition of those composite structures in the field.

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Fiber-reinforced polymer (FRP) pipe ready to be installed at a Reclamation project.

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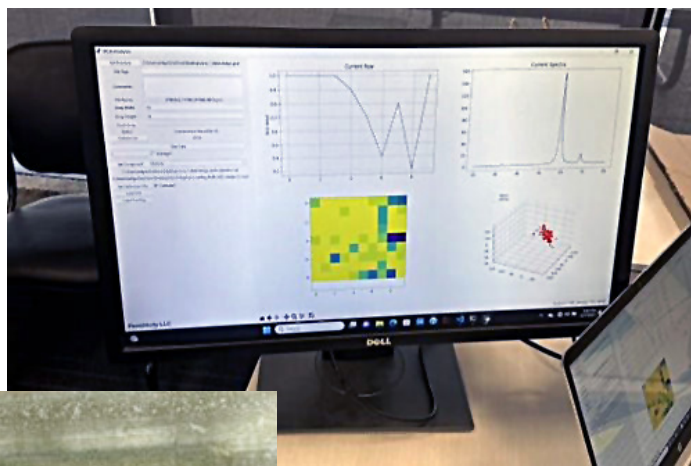
Imperfection Detection had three phases. In Phase 1, solvers submitted technical proposals describing their solution and plan. Many participants from around the world and across many technical disciplines submitted a white paper solution of an innovative method to non-destructively identify and locate defects in FRP composite structures. A team of subject matter experts review the proposed solutions for proposal quality, non-destructive evaluation characterization capabilities, appropriateness for field use, cost, project plan, and team. The evaluation team selected five winners to develop a prototype (lab-scale) version of their solution in Phase 2, each receiving a 12” x 12” test panel with engineered defects to support this. Following an added development period, Phase 2A, a single team met the minimum requirements and advanced to Phase 3, which utilized the test panel and several full-sized test pieces.

The finalist, Team Permittivity, delivered the prototype to the Reclamation Technical Service Center and demonstrated it on the test panel and test pieces for the judges. The system hardware is based on a SansEC sensor, which is an open circuit, spiral trace sensor system that was developed by NASA to detect defects in carbon fiber airplane wings. Team Permittivity customized the hardware and built upon that model to create a unit that detects defects in the denser, FRP composites.

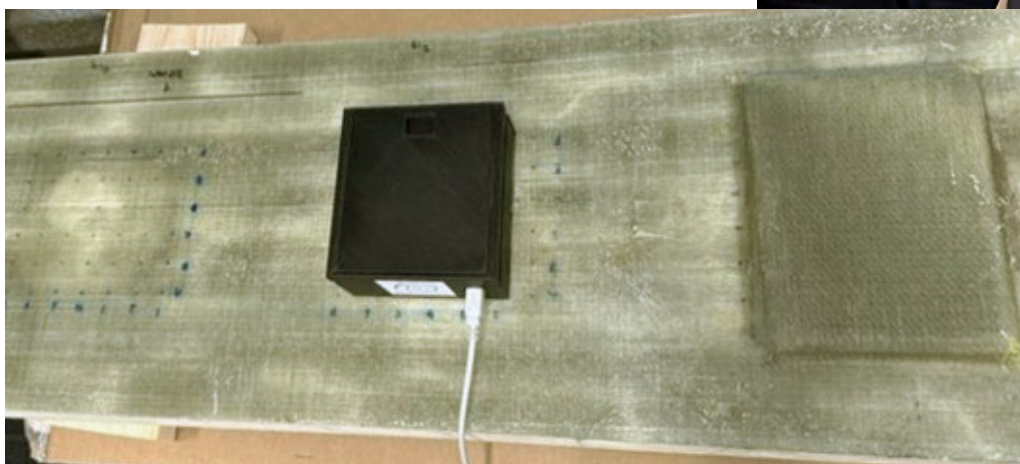
The Team Permittivity prototype applies an electromagnetic signal via a planar resonant sensor and analyzes six individual components related to permittivity with a principal component analysis (PCA) tool to differentiate between areas with defects and areas with no defects. The sensor is comprised of a copper coil that is flat to direct the magnetic field straight into the FRP. The system measures the magnetic permittivity of the FRP and compares it to areas that have different measurements of permittivity due to the sensor measuring the discontinuous material properties of a defect.

The judges then conducted an independent evaluation to determine if the finalist would win the full, partial, or no prize money. Additional non-cash prizes included being showcased in a final winner webinar and to have the potential to work alongside Reclamation in further development of the product.

Reclamation awarded Team Permittivity \$25,000 for their Imperfection Detection prototype. The prototype was not able to detect manufactured imperfections but was able to accurately flag the impact damage in USACE-provided FRP sandwich panel gate section. Although not meeting full award requirements, the novel approach showed good promise as a low-cost future solution. Identified areas for future development include to mitigate electromagnetic sensitivity, provide spatial data capabilities, and improve the software.



Team Permittivity software used for the analysis of FRP test pieces.



Team Permittivity sensor on an FRP sandwich panel during prototype evaluation.

Moving Prize Solutions into Practice

Streamflow Forecast Rodeo

By Lindsay Bearup & Ian Ferguson

lbearup@usbr.gov, iferguson@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA),
CEATI Hydropower Operations and Planning Interest Group (CEATI HOPIG), Topcoder

The Streamflow Forecasting Rodeo launched in August 2020 and aimed to improve forecast skill of short-term (10 day) streamflow forecasts. After a hindcast phase, monthly competitions challenged solvers to provide real time streamflow forecasts for the next 10 days. Participants also competed against benchmark forecasts, such as HydroForecast from Upstream Tech, supported by project partners including CEATI International's Hydropower Operations and Planning Interest Group, NASA Tournament Lab, Department of Energy's Waterpower Technologies Office, Tennessee Valley Authority, HydroQuebec and Topcoder.



Big Bend, Colorado River. (Photo by Alexander Stephens, Reclamation)

Reclamation selected 10 winners whose predictions most closely matched the actual streamflow at the forecast locations. Winners shared the \$435,000 in prize money. As reported in the Reclamation winners announcement, “Improving streamflow forecasts – will allow water management to be more efficient with storage and deliveries, opening new opportunities for reservoir operations,” said Reclamation Chief Engineer David Raff. “We are excited to explore the winning solutions with our forecasting and water management partners.”

The Streamflow Forecasting Rodeo was completed in FY 2022. In FY 2023, the Stream Forecast Rodeo moved from the prize competition space and into the facilitated adoption space. This is the first example of a prize competition solution-facilitated adoption continuum. The associated facilitated adoption project is described in the following article.

Facilitated Adoption of Streamflow Forecast Rodeo Solution

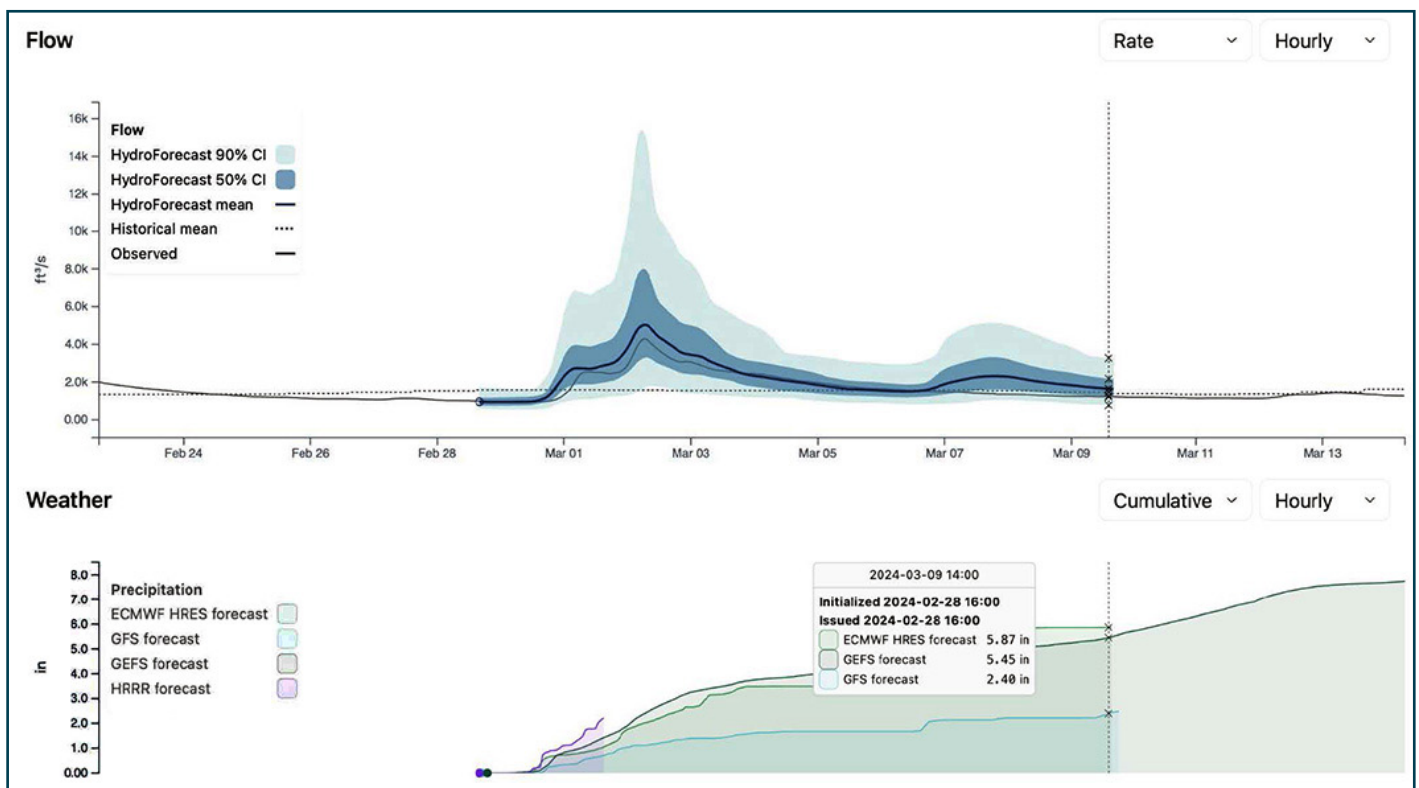
By **Lindsay Bearup & Ian Ferguson**

lbearup@usbr.gov, iferguson@usbr.gov

Partner(s): National Aeronautics and Space Administration (NASA),
CEATI Hydropower Operations and Planning Interest Group (CEATI HOPIG)

The Bureau of Reclamation’s (Reclamation) Research and Development (R&D) Office developed a Facilitated Adoption Program to fund projects that advance research results by piloting or demonstrating results from completed, successful research projects and prize competitions. In the first round of Facilitated Adoption projects, Reclamation funded a project to advance the high performing solutions from the Streamflow Forecast Rodeo prize competition, described in the previous article. The Streamflow Forecast Rodeo prize competition evaluated streamflow forecasts from various sources and compared their performance to spur innovation and advancement in forecasting.

Upstream Tech will develop pilot forecasts using the most skilled forecasting solution, as determined by the Streamflow Forecast Rodeo prize competition outcomes. The project will develop and deploy pilot forecasts at sites in each Reclamation region and assess the potential of broader Reclamation adoption for improving the skill and efficiency of streamflow forecasts. Selected basins for pilot forecasts represent a broad range of hydrologic conditions to support this assessment, including basins that are snowmelt dominated, rainfall-dominated, and those that experience a mix of rainfall and snowfall. This project is started at the end of FY 2023 and is on-going with the goal of having real-time forecasts next water year.



An example HydroForecast from the North Fork of the American river / Folsom basin that is driven by multiple weather forecasts to hedge against errors. (Credit: Laura Read, Upstream Tech)

This project will demonstrate the utility of these forecasts for Reclamation and will determine the ease of incorporating Upstream Tech’s technique for streamflow forecasts into operational practice at Reclamation. Potential benefits of moving this technology into practice are improved forecasts that results in better-informed operations decision and reduction in staff time because of modernization of tools and workflow.

Upcoming Prize Competitions

Innovative Boat Decontamination Methods to Stop the Spread of Invasive Mussels

By Sherri Pucherelli

spucherelli@usbr.gov

Watercraft inspection and decontamination programs are critical for preventing the spread of aquatic invasive species such as quagga and zebra mussels. Currently, decontamination of boats for the removal of invasive mussels includes a hot water treatment of the internal compartments such as ballast tanks. While this treatment is effective it is labor and time intensive, and difficult to implement on a large scale. The goal of this upcoming prize competition will be to identify a simple and effective method to kill invasive mussel larvae in ballast tanks that can be quickly applied and is safe for the applicator, boat, and environment. If successful, this solution will provide a ballast decontamination method that can be applied by boat owners or watercraft decontamination programs to stop the spread of invasive species.



Boat propeller covered with invasive quagga mussels after being submerged in Lake Mead for 11 months.

PFAS Sensing

By Saied Delagah & Anisha Lamsal

sdelagah@usbr.gov, alamsal@usbr.gov

A prize competition is in the design phase to develop novel PFAS sensing technologies to reduce the cost of PFAS sensing and test turn-around time. PFAS, including PFOA and other similar compounds, known as the indestructible chemical, have been used widely since the 1950's. Currently, the detection of PFAS, PFOA and similar compounds is not streamlined nor widely commercialized, resulting in increased costs for in-situ detection and detection and research studies. The goal of this potential prize competition is reduce sample analysis turn around time and analysis cost. Identifying cost effective mechanisms to measure these compounds would be a breakthrough in the water treatment industry and could have broader applications beyond water treatment.

Concentrate Management

By Saied Delagah

sdelagah@usbr.gov

In many areas, particularly in the Western United States, existing fresh water sources are fully allocated. Desalination is often overlooked or not considered due to its perceived high cost and its concentrate stream when inland communities are evaluating potential sources for new water supplies. Concentrate streams require additional handling, disposal and/or treatment. This stream contains most if not all of the salts in the feed and traps some of the feed water. Advancements have been made to reduce the volume of concentrate; however, additional solutions are needed to manage the final brine stream and its salt content. The goal of this prize challenge is to inspire novel technologies and processes to reduce and/or remove the concentrate barrier for more wide-spread adoption of desalination and usable water production.

Featured Faces

Lindsay Bearup

Civil Engineer – Hydrologic
Applied Hydrology 1, Technical Service Center

Lindsay Bearup is a civil engineer with the Applied Hydrology Group I in the Technical Service Center. She holds a Ph.D. in Hydrology from the Colorado School of Mines. After spending time setting up field sites in the Rocky Mountains, Lindsay joined Reclamation in 2016 and continues to pursue research and applications projects that involve snow, water quality and climate influences on the hydrologic system.



Anisha Lamsal

Environmental Engineer
Water Treatment, Technical Service Center

Anisha Lamsal is an environmental engineer with the Water Treatment Group at the Technical Service Center. She holds a Master's degree in Environmental Engineering from the University of Colorado - Boulder. At Reclamation, Anisha specializes in drinking water treatment research and design. She works on the implementation of clean drinking water and desalination projects for public facilities, tribal nations, and U.S. territories. She is looking forward to her involvement in Reclamation's prize competitions aimed at developing new or improving existing technologies in areas of water and the environment.



Christine VanZomeran

Prize Competition Program Administrator, R&D Office

Christine VanZomeran is the Prize Competition Program Administrator at Reclamation's Research and Development Office in Denver, CO. Dr. VanZomeran holds a Ph.D. in Soil and Water Science from the University of Florida. Her research background and interests are in wetland restoration and invasive species management. Dr. VanZomeran spent nine years at the U.S. Research and Development Center (ERDC) prior to joining Reclamation in February 2024. During her time at ERDC, Christine focused her research on wetland restoration from freshwater to saline systems and varying nutrient management levels. Additionally, Christine was involved with aquatic ecosystem restoration program management and program development for the last four years.



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