



— BUREAU OF —
RECLAMATION

Research and Development Office FY 2022 Highlights



Reclamation's Research and Development Office

The Research and Development Office (R&D) administers innovation programs to advance the agency's mission to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. R&D's two appropriated programs, Desalination and Water Purification Research and Science and Technology address the technical obstacles related to our mission. R&D also administers the Open Water Data program to provide bureau-wide water data publishing and enhance science and product dissemination from R&D programs. Learn more at: <https://www.usbr.gov/research>.

DWPR Projects

FY 2022 by the Numbers

- 24 Awarded Grants
- \$7.2M Federal Funding
- \$6.3M non Federal Match

Desalination and Water Purification Research (DWPR)

Reclamation's DWPR Program seeks to reduce the cost, energy consumption, and environmental impacts of using desalination and other water purification technologies to develop water supplies from otherwise unusable sources (e.g., brackish groundwater, sea water, produced water from oil and gas extraction, municipal wastewater).

Topics addressed by FY 2022 funded projects include:

- per- and polyfluoroalkyl substances (PFAS) treatment
- water treatment process optimization
- membrane development
- concentrate management
- water reuse process monitoring and optimization
- novel desalination approaches



BGNDRF research- includes University of Minnesota (concentrate management), MIT (PV-powered electrodialysis), Water Surplus (novel membranes & desalination flow management), Solar Multiple (concentrate management), University of Texas at El Paso (novel PV + desalination hybrid), and the University of North Texas (wind + PV powered desalination for agriculture).



Alamogordo, New Mexico, a focal point for developing technologies for the desalination of brackish and impaired groundwater found in the inland states. The facility supports piloting to full-scale testing of desalination and water purification technologies, concentrate management technologies, and projects utilizing renewable energy.

BGNDRF brings together researchers from federal, state, and local government agencies, universities, private sector, and research organizations to work collaboratively and in partnership. The facility hosted 19 projects with 10 continuing their work into FY 2022. The projects are funded by Reclamation, DOE, state agencies, and private industry.

In FY 2022, the facility hosted their fifth annual Virtual Water Innovations and Networking (WIN) Workshop with over 75 registrants and presentations over two days from clients and Reclamation-funded research.

Science and Technology Program (S&T) Research Projects

The S&T program funds innovative development, applied and demonstration research addressing the full range of technical issues confronting Reclamation water and power managers, customers, and stakeholders. Program research is funded in five areas:



Water Infrastructure (WI)

Dams, Canals, Pipelines, and Miscellaneous Water Infrastructure



Power and Energy (PE)

Hydro Powerplants, Energy Efficiency, Pumping Plants, and Non-Hydropower Renewable Energy



Developing Water Supplies (WS)

Water Treatment, Water Supply Augmentation, Groundwater Supplies, Agricultural and Municipal Water Supplies, and Water Losses



Environmental Issues in Water Delivery and Management (EN)

Water Delivery Reliability, Invasive Species, Water Quality, Sediment Management, and River Habitat Restoration

(Bottom left) Mussels research on coated sample coupons at Parker Dam, CA. (Top right) Installation of a demonstration PCCP pipe in the courtyard at the TSC in Denver, CO. (Bottom right) Applying a cavitation-resistant coating on Grand Coulee turbine runner, WA.

S&T Projects

FY 2022 by the Numbers

- 202 Active Projects
- 44 Completed Projects
- \$8.3M Federal Funding
- \$9.1M Non Federal Match



Water Operations and Planning (WP)

Water Supply and Streamflow Forecasting, Water Operations Models and Decision Support Systems, Open Data, and Climate Change and Variability



Science and Technology Program (S&T) Highlighted Research Projects



(EN) Monitoring the Movements of Juvenile Pacific Lamprey in the Yakima River using Acoustic Telemetry

Problem: Many fish species migrate hundreds to thousands of miles seeking various habitats during different phases of their life. Flow regulation and water diversions can affect migration and survival by reducing flood flows or by direct injury. Improving fish survival as they pass dams is an important conservation strategy. Acoustic telemetry transceivers (tags) outperform other methods for tracking fish in aquatic environments, however, commercially available acoustic tags are currently too large for many fish.

Solution: The project aimed to produce acoustic telemetry tags smaller than commercially available ones. Tag loss can be a significant confounding factor for data analysis and smaller tags have better tag retention rates, are easier to implant, and impact fish behavior less.

Impact: Cost savings from reduced labor and reduction in lost tags. Other benefits include increased fish survival rates.

Total Federal Cost: \$0.15M

Benefit Cost Ratio: 10.7

(PE) Power System Instrumentation

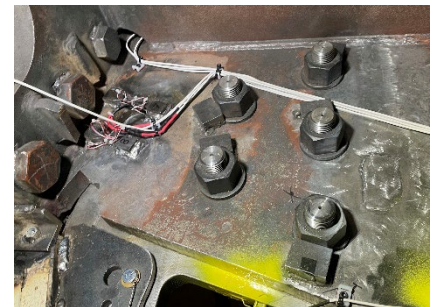
Problem: Specialized technology is not currently available as an integrated solution to actively monitor operation and maintenance (O&M) challenges on hydropower machines.

Solution: New online monitoring capabilities provide non-traditional approaches to O&M that are more cost effective and flexible. Researchers developed a new data acquisition system and sensors, i.e., proximity probes and strain gages, using off the shelf products to monitor rotors in hydroelectric generators for immediate understanding of rotor conditions such as crack monitoring and rotor rim float.

Impact: The new capabilities reduce O&M costs, outage time, and labor costs while at the same time allowing for more flexible operations leading to increasing the reliability of water and power delivery in the Western United States.

Total Federal Cost: \$0.1M

Benefit Cost Ratio: 52.8



(WI) Remotely Operated Vehicle (ROV) for Data Collection

Problem: Access for bathymetric surveys can be challenging using traditional approaches. Manned boats are commonly used but cannot access shallow areas and require portaging at crossings, resulting in missed data and higher inspection costs.

Solution: Researchers investigated unmanned surface vehicles (USVs), a type of ROV, to reduce inspection costs, increase safety, and collect data in difficult-to-access areas.

Impact: Implementing new USV technology will add valuable data and reduces labor.

Total Federal Cost: \$0.03M

Benefit Cost Ratio: 7.0

(PE) Strain Sensing Technology

Problem: Hydroelectric facilities have critical bolted joint connects, which if failed, could cause catastrophic consequences such as flooding of the powerplant. Many of these connections are in inaccessible areas making inspection difficult.

Solution: This research investigated the use of modern sensor technology to monitor the tightness and health of these threaded connections by using 'smart' fasteners. Commercially available sensors were installed and evaluated on several critical bolted connections to measure load/torque without removing or loosening the bolts.

Impact: The solution reduces catastrophic failure risks, increases O&M efficiency by reducing the labor needed and the frequency, and increase safety of plant personnel and the public.

Total Federal Cost: \$0.3M

Benefit Cost Ratio: 44.3



GIS Program Activity FY 2022 By the Numbers

- BORGIS data request/day: 120,000+ from 1,500 users

Geographic Information Systems (GIS)

The GIS Program administers geospatial data and services to support mission related activities, including investments in new technology, custom applications for programs, GIS training, and community building to assess the capabilities and capacity of Reclamation GIS staff to meet growing needs and fill gaps.

FY 2022 implementations for GIS platform:

- BORGIS GeoPlatform deployed Q4 to support mobile data access and field data collection
- Developed and implemented workflows to host and maintain Asset Registry Project data
- Established GIS Data Managers Team to catalog, curate, and manage Reclamation geospatial data assets

OWD Activity FY 2022 By the Numbers

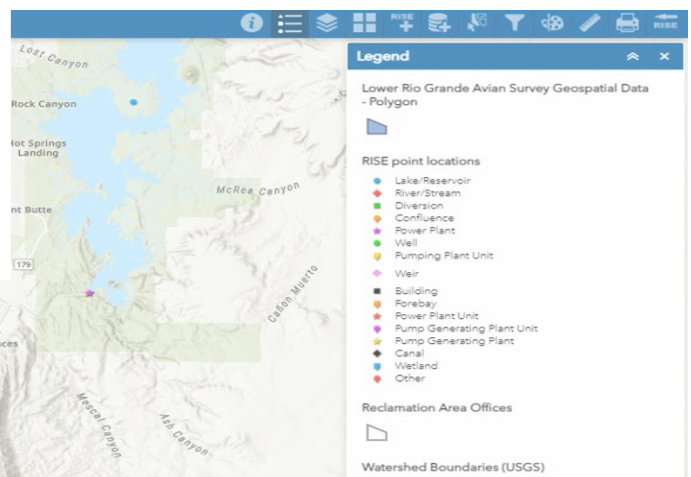
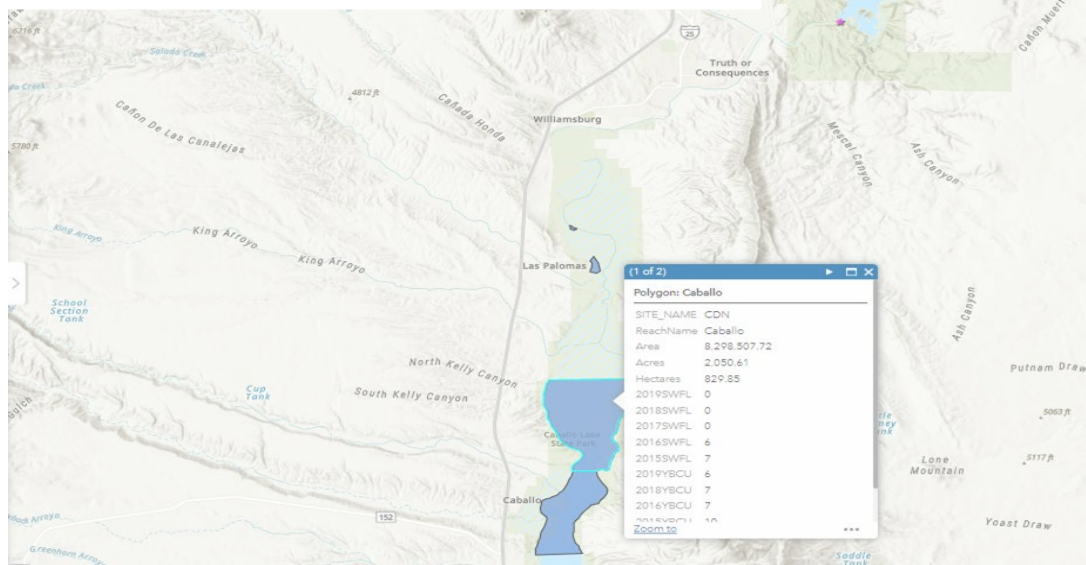
- Datasets published in RISE: 663 available catalog records as of 9/30/2022
- RISE Releases: 9 deployments resulting in 157 changes
- Average Monthly RISE Users: 940

Open Water Data

The Open Water Data Program focuses on making Reclamation’s mission-related data available in open formats for broad public use and supports implementation of the OPEN Government Data Act. Program activities include developing, operating, and maintaining the Reclamation Information Sharing Environment (RISE) system for publishing open datasets, coordinating with regions and programs through the Open Data Team to develop open data policy and implement best practices, and interfacing with internal and external partners to enhance data access and use.

In FY 2022, the Open Water Data Program continued to develop and add data to RISE (<https://data.usbr.gov>). RISE provides a platform for Reclamation programs and offices to publish water, hydropower, environmental, and related data for both internal and external data consumers.

Also in FY 2022, the Open Data Team began an effort to identify how Reclamation offices and programs currently share data, as well as what web-based visualization and analysis tools are currently used to support data use. The Team also began developing uses cases of data sharing to inform future development of data sharing policy and guidance.



Screenshot of RISE Map Interface showing point locations of available time series data at Caballo Reservoir and Elephant Butte Reservoir along with a geospatial dataset of avian survey data for the Lower Rio Grande.

Prize Competitions Program FY 2022 by the Numbers

- 3 Competitions Launched
- 7 Completed Competitions
- 29 Winning Solutions
- \$2.2M Cash Prizes Awarded

S&T Prize Competitions

Reclamation continues to use prize competitions to harness the innovative capacity of the public and private sector to identify alternative approaches to longstanding issues or advance research supporting Reclamation's mission and stakeholder interests.

In FY 2022, Reclamation launched three competitions. These competitions are reaching an international community of solvers and include:

- *Veg Out Challenge: Managing Aquatic Vegetation in Canals*— seeks solutions that develop new and improved methods to manage rooted (or attached) aquatic vegetation in canals.

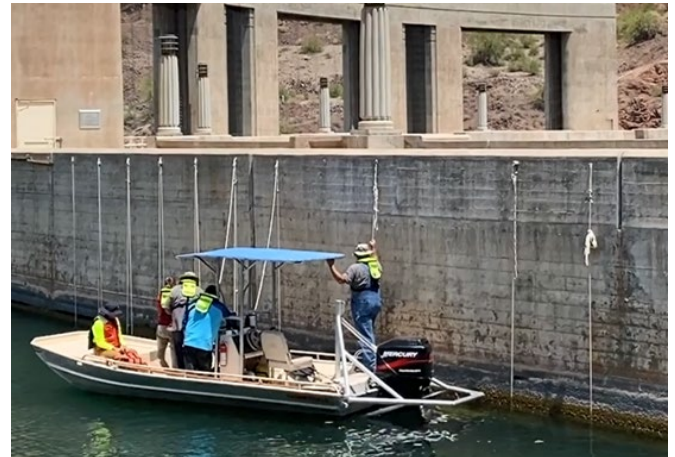


- *Counting Every Drop Challenge*— The competition aims to find new or improved ground-based precipitation measurement devices that are reliable, accurate, low maintenance, and able to operate in remote locations under extreme environmental conditions.
- *Snowcast Showdown*— This competition seeks to develop models to estimate snowpack water storage for streamflow and water supply forecasting, using machine learning tools.

In FY 2022, seven competitions concluded with the following awards given out to solvers:

- *Water America's Crops*- two winners received awards for their ideas for improving water delivery by reducing water seepage from canals. The first place winner received \$90,000 for idea involving bendable concrete for seepage resistance. The second winner received \$20,000 for a low cost elastomeric canal liner.

- *More Water Less Concentrate Challenge*— finalists demonstrated prototype technologies at Reclamation's Water Quality Improvement Center at the Yuma Desalting Plant. Five teams divided the \$825,000 prize purse.
- *Guardians of the Reservoir Challenge*— solvers performed a demonstration of their ideas addressing reservoir sedimentation. D-Sediment was announced as the overall competition winner receiving \$100,000 for their solution to remove reservoir sediment.
- *Snowcast Showdown*— \$500,000 in awards were distributed amongst five teams in allotments related to performance in two phases of the competition: prediction and model evaluation.
- *Automated Maintenance of Protection Systems (AMPS) Challenge*— two teams received \$50,000 in awards for their ideas to automate protection systems for hydropower generators, with one of those teams receiving an extra \$7,500. A third team received \$40,000 for their solution and an additional \$2,000 was given to a fourth team.
- *Streamflow Forecast Rodeo*— ten teams shared the \$435,000 prize purse for 10-day streamflow forecast predictions based on how well they predicted actual streamflows.



- *Rustbusters: Join the Resistance*— field and laboratory prototypes were evaluated for best corrosion resistance in immersion service. A first place winner received \$65,000 for their high barrier controlled release coating solution and a second winner received \$35,000 for their innovative robotic coatings application method.

In multi-phase competitions, competitors are often provided opportunities to develop, demonstrate, and test their proposed solutions. They may also receive technical input or engagement from subject matter experts as they advance their solutions. Prize competitions complement traditional research by providing another tool to help find breakthroughs or overcome technical obstacles and complexities. Reclamation is continuing to work internally and with prize winners to further develop solutions received from completed competitions.



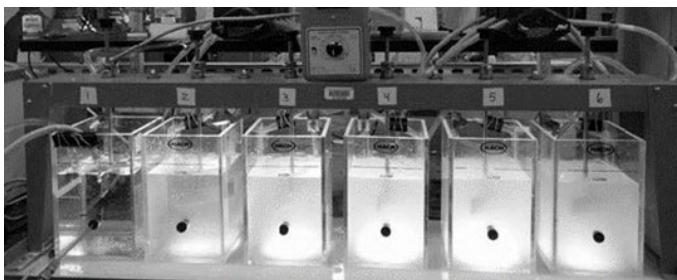
Seepage measurements taken at Truckee Canal.

Snow Water Supply Forecast Program

The Snow Water Supply Forecasting Program Authorization Act, 2020, establishes the Snow Water Supply Forecasting Program within the Department of the Interior (DOI). The Research and Development office is implementing the Program to advance emerging technologies to enhance snow monitoring and subsequent water supply forecasts. In FY 2022 the Program:

- produced Emerging Technologies in Snow Monitoring Report to Congress.
- prepared an grant opportunity to award up to \$11.75M for projects that will enhance snow monitoring and water supply forecasting
- Collaborated with federal partners at NRCS and NOAA to support the advancement of water supply forecasting technologies.
- Provided \$1.7M in funding for 17 projects led by Reclamation researchers to advance the usages of snow monitoring data within Reclamation

Experimental set-up measuring crystallization kinetics of sparingly soluble salt mixtures.



S&T Technology Transfer

The S&T Program pursues a variety of joint venture research partnership agreements by leveraging Technology Transfer (TT) with the private sector.

This includes Cooperative Research and Development Agreements (CRADA), Materials Transfer Agreements (MTA), and Facility Use Service Agreements (FUSA), among others, where industry plays a role in maturing and transforming research results into usable, manufactured products that can be supplied to Reclamation and the broader water management community.

TT Activity Summary FY 2022 by the Numbers

- 5 CRADAS
- 2 MTAs
- 2 Patent License Agreements
- 1 New Patent Awarded



Laboratory scale model of a water storage tank with a cathodic protection corrosion mitigation system installed.

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\$300,000 IN TOTAL PRIZES



BUREAU OF RECLAMATION
Knowledge Stream
 Research and Development Office

Innovation in Sustainable Reservoir Sediment Management



U.S. Department of the Interior
 Bureau of Reclamation Office
 Research and Technology Program

Econometric Analysis and Forecast Model for Reclamation Corrosion Protection Costs

Research Bulletin
 887 Project 19195

Mission Issue
 Cost-effective methods to reduce the amount of water lost to evaporation and seepage from reservoirs are needed to increase the reliability of water delivery and power generation.

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Problem
 The Bureau of Reclamation (Bureau) operates and maintains 188 hydroelectric power projects and an equivalent number of additional large and small Bureau steel pipes with associated metal pipes. The 188 projects cover a combined area of 6.6 million square feet of steel surface area. The steel surface requires protective coatings to prevent corrosion damage, e.g., metal loss by wall thinning and pitting, which leads to increased wall exposure and water seepage. Corrosion damage reduces the reliability of water delivery and power generation and can lead to pipe failure or environmental damage.

The projects each associated with cost relating to coating and including product, material, labor, and other costs. The cost of corrosion and maintenance helps to the facility to be more cost-effective and to be more resilient. The data are extensive. Recent experience suggests an interest in the Bureau and need of its maintenance, including that from budget cuts may be being done understanding their own needs and improving the available cost estimating needs of budgeting, pricing, and construction.

Solution
 An econometric analysis of pipe physical factors and related data was conducted to forecast cost (2018) associated with maintenance and repair of steel pipes. The analysis included the use of statistical methods to examine data and identify the relationship of factors to identify statistically significant variables, relationships, and trends. Understanding the cost drivers for these existing pipe replacement and repair opportunities to assess efficiency. A final report would that estimate pipe forecast the existing cost as a function of steel replacement variables are developed.