BUREAU OF RECLAMATION

Research and Development Office FY 2024 Highlights

U.S. Department of the Interior

June 2025

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, Science and Technology and Desalination and Water Purification Research, address the technical obstacles related to our mission. R&D also administers Reclamation's Open Water Data and GIS programs, providing bureau-wide water data publishing and geospatial capabilities to staff. Learn more at: https://www.usbr.gov/research.

Science and Technology (S&T) Program

S&T Internal Research

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 and Pumping Plants

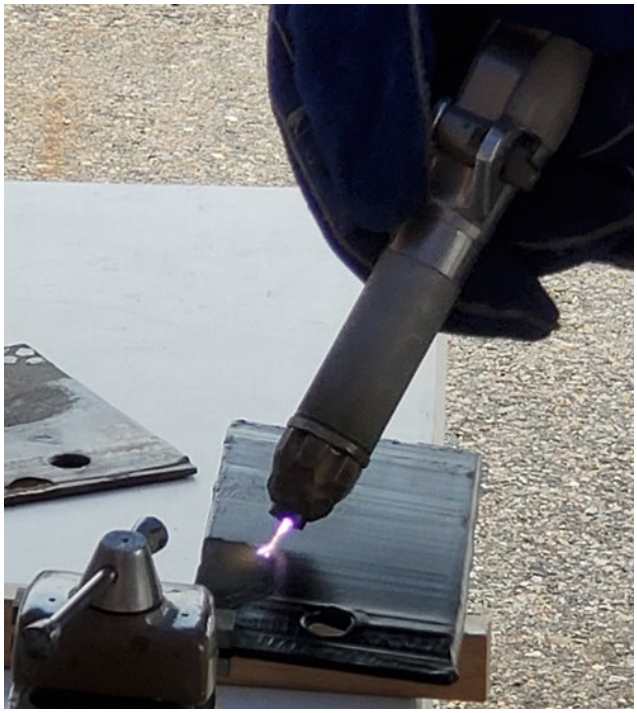
Developing Water Supplies (WS) Water Treatment, Water Supply Augmentation, Groundwater Supplies, Agricultural and Municipal Water Supplies, and Water Losses

Environmental Issues in Water Delivery and Management (EN)
Water Delivery Reliability, Invasive Species, Water Quality, Sediment Management, and River Habitat Restoration

Water Operations and Planning (WP)
Water Supply and Streamflow Forecasting, Water Operations Models and Decision Support Systems, Open Data, and Hydrologic Variability

Internal Research
FY 2024 by the Numbers

- **118 Active Projects**
- **29 Completed Projects**
- **$3.4 M New Federal Funding**
- **$6.6 M Non-Federal Match**



Top photo: View of atmospheric plasma removing coal tar enamel from a test panel, from "Atmospheric Plasma Coating Removal" (Project 21062). Bottom photo: Ultraviolet light tool designed to control invasive aquatic plants, mounted on a boat in an irrigation canal, from "Maintaining Canal Capacity and Delivery Feature Reliability through UV Aquatic Vegetation Control" (Project 20041).

S&T Highlighted Research Projects

(WI) Boundary Layer Effects on Hydraulic Jacking in Spillway Chutes

Hydraulic jacking failure at Oroville Dam, California, in 2017.

Problem: Hydraulic jacking failures are a major concern for spillways and other high-velocity waterways or chutes. These concrete structures must be constructed with special joints to prevent cracking, but the concrete panels are also prone to displacement at these joints over time. Joint displacements can cause offsets in the flow, which result in high pressures that can be injected into the foundation. When high pressure water penetrates through cracks or open joints and pressurizes large areas of the foundation, the result can be a hydraulic jacking failure, causing significant damage that may result in an operational emergency.

Solution: This project synthesized results from physical and numerical modeling experiments to better estimate flow through joints and cracks, uplift pressure heads, and the effects of different joint and crack remediation strategies on hydraulic jacking.

Impact: Findings from this study can be used to estimate uplift pressure heads on spillways, coating failures in pipelines, high-velocity flow environments, and sediment bypass tunnels, ultimately supporting improved designs.

Total Federal Cost: $0.8M Benefit Cost Ratio: 52

(WP) Risk-Based Decision Making in Reservoir Operations

Problem: Reservoir operations at some facilities rely on deterministic forecasting methods that overlook the inherent uncertainties in inflow predictions and do not evaluate water management risks in a systematic way. These gaps can lead to suboptimal decision-making, particularly during critical periods of reservoir filling in snowmelt dominated regions.

Solution: The study team designed and implemented a risk-informed decision-making (RIDM) framework and tools using ensemble hindcasts combined with a hydrologic model and a reservoir operations model to better quantify inflow uncertainties at Buffalo Bill Reservoir, Wyoming.

Impact: The development and application of a risk-based operations approach allowed researchers to consider inflow uncertainties and resulting consequences to multiple reservoir objectives, including irrigation, municipal water supply, hydropower, flood control, fisheries, and recreation. These tools are now being applied to other reservoir operations applications in Reclamation.

Total Federal Cost: $0.3M Benefit Cost Ratio: 6

(PE) Develop a Cost Effective, Flexible Excitation and Governor Control System Platform

Problem: Hydropower turbines operating in off-design conditions may face issues such as cavitation-erosion, excessive vibrations, and unit fatigue. Repairs can worsen these issues by adding stress and altering turbine blade designs, ultimately reducing turbine lifespan.

Solution: The project team developed a simple, low-cost excitation and governor controller using commercially available hardware combined with Reclamation-made control algorithms to improve techniques for detecting and mapping turbine cavitation erosion and its intensity.

Impact: The developed technology integrates into existing systems, decreasing design, installation, commissioning, and maintenance costs.

Total Federal Cost: $1.3M Benefit Cost Ratio: 6.3

New voltage regulator control system at Fontenelle Powerplant, Wyoming.

(WS) Scaling Resistant Reverse Osmosis/Nanofiltration Membranes

Problem: The reverse osmosis water treatment process produces drinking water and a concentrated brine output stream, which can be particularly challenging and costly to dispose of at inland treatment locations.

Solution: The project team designed and conducted laboratory experiments to evaluate the scaling resistance of different reverse osmosis membrane chemistries.

Impact: A more scaling resistant membrane will allow an inland desalination facility to both produce more usable water and minimize the volume of concentrated brine produced.

Total Federal Cost: $0.9M Benefit Cost Ratio: 27

(PE) Online Monitoring of Protection Systems

An automated battery backup system installed on the station service battery at Glen Canyon Powerplant, Arizona.

Problem: Operation of protection systems in powerplants is critical to ensure the safety of Reclamation employees and power generation equipment. Significant testing and maintenance of these systems is required by the North American Electric Reliability Corporation and Reclamation FIST. Maintaining these systems is costly with inherent risks associated with testing and normal maintenance, including damaged equipment and/or extended outages, and increased risk of noncompliance when not monitored.

Solution: Researchers deployed online protection system monitoring solutions at three pilot sites to perform continuous verification of critical protection system components and eliminate the need for periodic, offline testing.

Impact: This project demonstrated the benefits of online monitoring solutions, which include improving the accuracy and consistency of compliance data, satisfying regulatory requirements, detecting issues quickly, and reducing outage time for testing. With this technology, Reclamation can achieve greater operational efficiency, reduce risks, and ensure the continued reliability of the electric power system.

Total Federal Cost: $0.3M Benefit Cost Ratio: 12

S&T Prize Competitions

Prize Competitions
FY 2024 by the Numbers

- **3 Completed Competitions**
- **7 Winning Solutions**
- **10 Winning Solutions**
- **$569,000 Cash Prizes Awarded**
- **4 Completed Technology Searches**

Reclamation continued to utilize the innovative approach of crowdsourcing through Prize Competitions to identify alternative approaches to challenges encountered supporting Reclamation's mission and stakeholder interests.

In FY 2024, Reclamation initiated scoping and development of two new prize competitions, one competition on PFAS sensing and one competition on sealing large conduits. These competitions are planned for launch in FY 2025 and will reach international communities of solvers.

In FY 2024, three competitions concluded with the following awards given out to solvers:

- *Counting Every Drop Challenge*– Three winning teams were selected and awarded prize purses for this challenge. The Precipitation Measurement with Advanced Solid-state Sensors team was awarded $73,000, the Intelligent Precipitation Measurement team was awarded $63,000, and the Precipitation Guage with Redundant Array of Weight Scales team was awarded $48,000 in prize purses.
- *Veg Out Challenge:* Managing Aquatic Vegetation in Canals– The AquaInject, Where IoT Meets Vegetation Control team was selected as the 1st place winner of the challenge and received a $75,000 prize purse award. The Packaged Herbicide for More Efficient Control team was selected as the runner up and received a $35,000 prize purse award.

Veg Out Challenge 1st place AquaInject solution

- *Water Supply Forecasting*- Five winners were selected and awarded $275,000 based on overall advancements made in methods for seasonal water supply forecasting. 1st place was awarded $100,000, 2nd place was awarded $75,000, 3rd place was awarded $50,000, 4th place was awarded $30,000, and 5th place was awarded $20,000.

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.

Technology searches were identified as an additional tool to help define the problem and solution boundaries for prize competitions. In FY 2024, four technology searches were completed:

- PFAS Sensing
- Sealing Large Conduits
- Subsurface Crack Detection
- Water Information Systems

S&T Facilitated Adoption

Facilitated Adoption
FY 2024 by the Numbers

- **9 On-going Projects**
- **9 New Projects**

In FY 2024, the R&D Office continued the S&T Facilitated Adoption Program to demonstrate the use of results or transferring knowledge from a completed project to enable the use of the results. Eligible projects are completed S&T Research projects or solutions from Prize Competitions. Nine new projects were selected in FY 2024 for Facilitated Adoption and nine projects continued from FY 2023.

S&T Snow Water Supply Forecasting Program

Snow Water Supply Forecasting
FY 2024 by the Numbers

- **5 Awarded Grants**
- **$4.6M Federal Funding**
- **$4.6M Non-Federal Match**
- **18 ongoing projects**

The Snow Water Supply Forecasting Program Authorization Act, 2020, established 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 improve water supply forecasts. In FY 2024 the Program:

- Selected projects totaling $4.6 M that will enhance snow monitoring and water supply forecasting through the implementation of aerial LiDAR snow surveys.
- Collaborated with federal partners at USDA and NOAA to support the advancement of water supply forecasting technologies. This included developing and awarding 4 projects that enhance federal forecasting agencies' capabilities to leverage investments in snow monitoring, building 'landing strips' for recent and future innovations.

Snowpack in the mountains of Colorado.

S&T Technology Transfer

Technology Transfer
FY 2024 by the numbers

- **2 New CRADAs**
- **2 Ongoing CRADAs**
- **4 New MTAs**
- **4 Ongoing MTAs**

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. For example, Reclamation has partnered with GE via a CRADA to conduct cavitation monitoring and improved inspection techniques at hydropower facilities.

Desalination and Water Purification Research (DWPR)

DWPR External Research

DWPR Projects
FY 2024 by the Numbers

- **21 Awarded Grants**
- **$5.6M Federal Funding**
- **$3.7M Non-Federal Match**

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, seawater, produced water from oil and gas extraction, municipal wastewater). Topics addressed by FY 2024 funded projects include:

- Per-and polyfluoroalkyl substances (PFAS) separation and treatment
- Separation and recovery of nutrients and other valuable byproducts from brine streams
- Novel membrane development and optimization to increase water recovery
- Concentrate minimization and management
- Submerged water filtration for seawater desalination
- Innovative desalination technologies and methods

Hot air balloon rising over BGNDRF.

Brackish Groundwater National Desalination Research Facility (BGNDRF)

The DWPR program funds the operation and maintenance of BGNDRF, located in 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 and full-scale testing of innovative desalination, water purification, and concentrate management technologies used to increase water supplies.

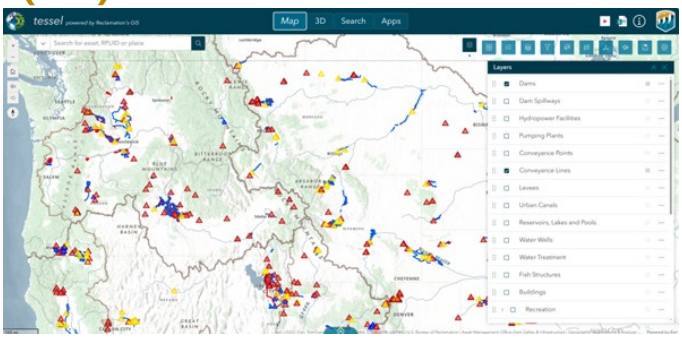
BGNDRF brings together researchers from federal, state, and local government agencies, universities, private sector, and research organizations to work collaboratively and in partnership. The facility hosted 15 projects in FY2024 with additional projects beginning in FY2025, funded by Reclamation, research consortiums, and private industry.

In FY 2024, the facility hosted their seventh annual Water Innovations and Networking (WIN) Workshop with over 80 registrants and presentations over two days from recent clients and Reclamation researchers.

Indoor test bays at BGNDRF.

Data Programs

Geospatial Information Services (GIS)



Reclamation staff can access and explore curated GIS data and applications through Tessel – your 'one stop shop' for GIS resources.

GIS Program Activity
FY 2024 By the Numbers

- **680 actively managed data layers including 276 available to all staff**

The GIS Program promotes data management principles, enterprise GIS data, a community of practice, and the effective use of geospatial technology to support Reclamation's mission, our partners, and the public.

FY 2024 Accomplishments:

- Developed and implemented workflows to host and curate mission-essential data (dams, water conveyance, land ownership).
- Built the Reclamation GIS Community to include 1000 members sharing information via newsletters, webinars, and an active 'Ask a GIS Question' helpdesk.
- Hosted 11 GIS training events for 190 staff to improve field data collection efficiency, effective map design, Python scripting to build analysis tools with ArcGIS Pro.
- Implemented geospatial metadata standards and self-paced training resources.
- Contributed to the development of interdepartmental MAPLand Act data standards.

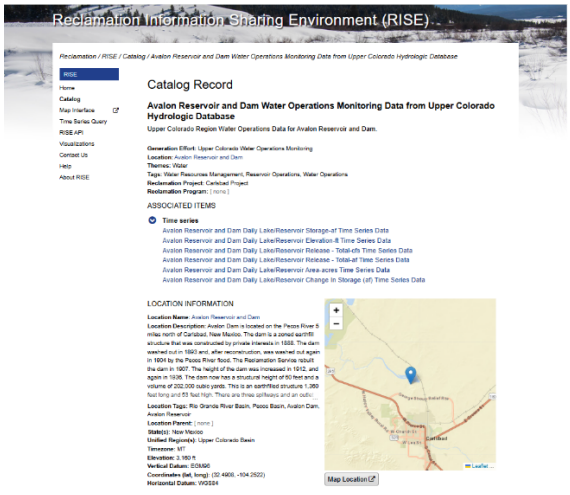
Open Water Data (OWD)

The Open Water Data Program focuses on making Reclamation's 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 system (RISE, https://data.usbr.gov) for publishing open datasets, supporting Reclamation data stewards in publishing data in RISE, coordinating with Reclamation staff on open data-related topics through the Open Data Team, and interfacing with external partners to enhance data access and use.

OWD Activity
FY 2024 By the Numbers

- **New datasets published in RISE: 20**
- **Number of datasets available in RISE: 703 records as of 9/30/2024**
- **Number of RISE feature updates: 5 releases resulting in 64 changes**
- **Average Monthly RISE Users: 604**

In FY 2024, the Open Water Data Program continued to develop RISE, making it easier for data publishers and data consumers to use. Enhancements included redesigning catalog item details pages to make data more intuitive to access, helping users get API request URLs for time series queries, expanding editing capabilities for data stewards, and improving the Reservoir Conditions visualization.



The updated RISE Catalog Record Details pages provide an overview of available data and easy access to individual datasets.

Also in FY 2024, the OWD Program supported publication of numerous datasets in RISE, including Science and Technology Program research products and additional water operations monitoring data from the Upper Colorado Basin Region. The OWD Program also kicked off a project with the Internet of Water Initiative to develop an interoperable western water data hub.

Front cover photo: Keswick Dam, CA
Back cover photo: Hydropower generating units at Glen Canyon Dam, AZ