



— BUREAU OF —  
RECLAMATION

# Research and Development Office FY 2021 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 products dissemination from R&D programs. Learn more at: <https://www.usbr.gov/research>.

## DWPR Projects

### FY 2021 by the Numbers

- ◆ 88 Applications
- ◆ 19 Awarded Grants
- ◆ \$5.2M Federal Funding
- ◆ \$5.4M non-Federal Match

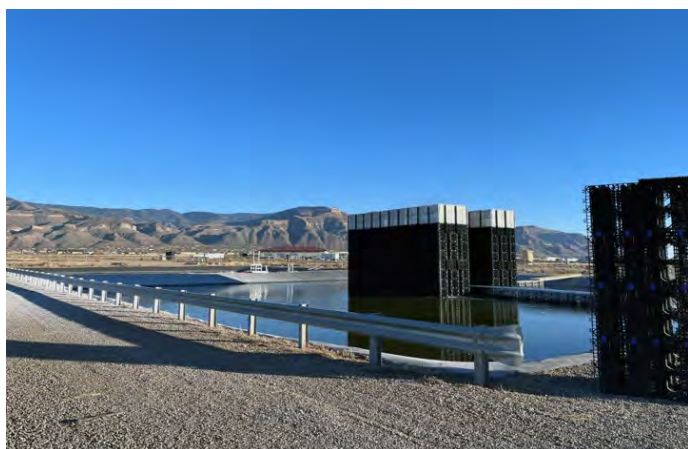
## Desalination and Water Purification Research (DWPR)

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).

These are the challenges and solutions proposed by FY 2021 funded projects:

Challenges being addressed:

- per-and polyfluoroalkyl substances (PFAS) removal
- silica and selenium removal
- carbon nanotube coatings
- concentrate management
- optimization via machine learning



Client at BGNDRF – EcoVap enhance evaporation pilot testing unit, funded by DWPR Pitch to Pilot.



Indoor test bays at BGNDRF.

## Brackish Groundwater National Desalination Research Facility

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 to full-scale testing of desalination and water purification technologies.

BGNDRF brings together researchers from Federal government agencies, universities, the private sector, research organizations, and state and local agencies to work collaboratively and in partnership. The facility hosted over 14 different projects with 12 out of the 14 continuing their work into FY2022.

In FY2021, the facility hosted their second Virtual Water Innovations and Networking (WIN) Workshop with over 150 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



### Developing Water Supplies (WS)

Advanced Water Treatment, Groundwater Supplies, Agricultural and Municipal Water Supplies, and System Water Losses

## S&T Projects

### FY 2021 by the Numbers

- ◆ 202 Active Projects
- ◆ 50 Completed Projects
- ◆ \$12.0M Federal Funding
- ◆ \$9.7M non-Federal Match



### Environmental Issues in Water Delivery and Management (EN)

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



### Water Operations (WP)

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



Live pen experiment at Shag Slough, San Francisco Bay-Delta, California, to evaluate distance and conditions at which environmental DNA from fish species can be detected.



Quagga mussel fouling on a fixed wheel gate at Glen Canyon Dam.



Glen Canyon Dam and Lake Powell near Page, Arizona. Photo from WP Project 19264: Exploring the use of temperature to understand recent drought and project future conditions in the Colorado River Basin - Rebecca Smith.

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



### **(WI) Geospatial Tool for Instrumentation Inventory and Collection and Evaluation of Readings**

**Problem:** Data collection and validation of routine readings lacked a geospatial inventory of instruments and real time data transmission.

**Solution:** The project developed and demonstrated two options for single-entry mobile apps with near real time evaluation of performance parameters.

**Impact:** The app allows personnel to locate instruments and enter readings on a mobile device, confirm they are within performance parameters, and transmit—all while in the field.

Total Federal Cost: \$0.10M

Benefit Cost Ratio: 11.4

### **(PE) Rotor Installed Corona Mapping of Stator Windings within Large Diameter Hydro Generators**

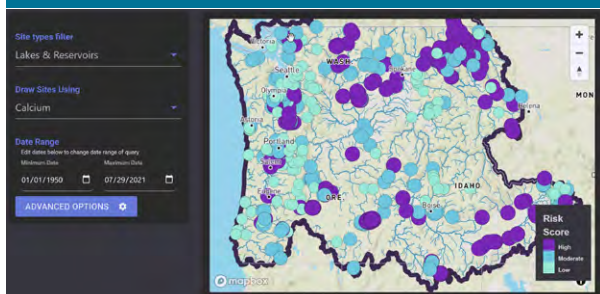
**Problem:** Partial discharge in stator windings can lead to damage and forced outages, and previous techniques were time-intensive or insufficient resolution.

**Solution:** Near field communication antennas mounted to the rotor can map partial discharge activity with slot level resolution through the stator winding.

**Impact:** Trending of partial discharge activity without the need to remove the rotor significantly reduces cost, hazards, and risks with obtaining the data.

Total Federal Cost: \$0.19M

Benefit Cost Ratio: 9.6



### **(EN) Risk Mapping for Mussel Infestation in the CPN**

**Problem:** Early detection of invasive mussels requires resource prioritization.

**Solution:** A web interface for predicting invasive mussel risk was developed in partnership with the USGS. The interface maps establishment risk based on Ca and pH which are continuously queried from the National Water Quality Portal.

**Impact:** Will improve efficiency of mussel control resource deployment, so the same dollars spent will have a greater impact and realize value.

Total Federal Cost: \$0.15M

Benefit Cost Ratio: 14.5

### **(WP) Merging high-resolution airborne snowpack data with existing long-term hydrometeorological observations to improve water supply forecasting**

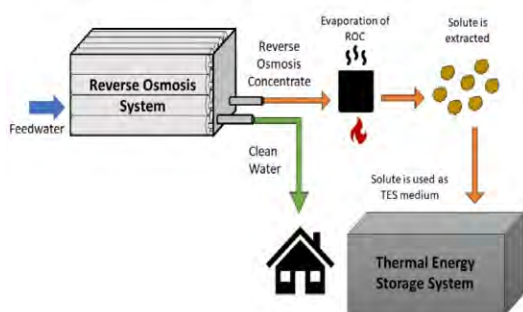
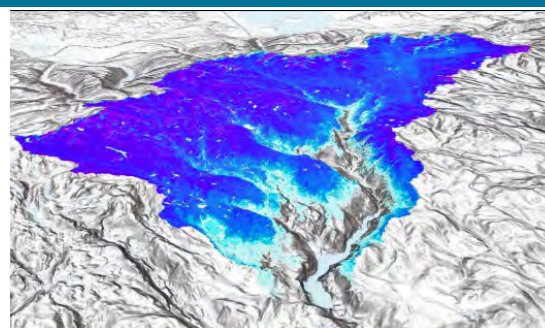
**Problem:** Aircraft lidar snow surveys provide high quality snow information but are a resource intensive data collection process.

**Solution:** Statistical models were developed to relate point station snow data with past aircraft lidar surveys to develop basin-wide snow water equivalent (SWE) estimates.

**Impact:** Models developed from this work can increase access to high quality basin wide SWE estimates and may decrease the frequency of needed aircraft lidar surveys.

Total Federal Cost: \$0.25M

Benefit Cost Ratio: 8.7



### **(WS) An Ultra-low-cost Thermal Energy Storage System using Reverse Osmosis Concentrate**

**Problem:** The reject of the reverse osmosis water treatment process (aka brine, concentrate) is a mixture of salts that are dissolved in high salinity water and is classified as an industrial waste with limited disposal options.

**Solution:** In this study, the feasibility of using reverse osmosis concentrate as a low-cost Thermal Energy Storage (TES) medium was explored by a techno-economic analysis.

**Impact:** It was shown that the normalized cost of TES using ROC salt content is in the range of \$6.11 to \$8.73 per kilowatt-hours depending on reverse osmosis concentrate processing methods.

Total Federal Cost: \$0.20M

Benefit Cost Ratio: 7.8

## 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 coordinating S&T research projects related to open data, developing and operating an open data publication IT system, and interfacing with internal and external partners to enhance data access and use.

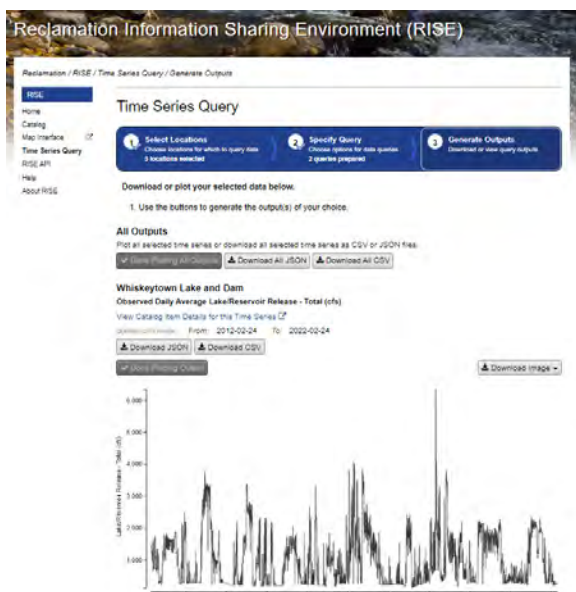
In FY2021, Reclamation continued to develop and add data to its open data portal, the Reclamation Information Sharing Environment (RISE) at <https://data.usbr.gov>. RISE provides a platform for Reclamation programs and offices to publish water, hydropower, environmental, and related data for both internal and external data consumers. The site includes a data catalog listing available datasets,

### OWD Activity FY 2021 By the Numbers

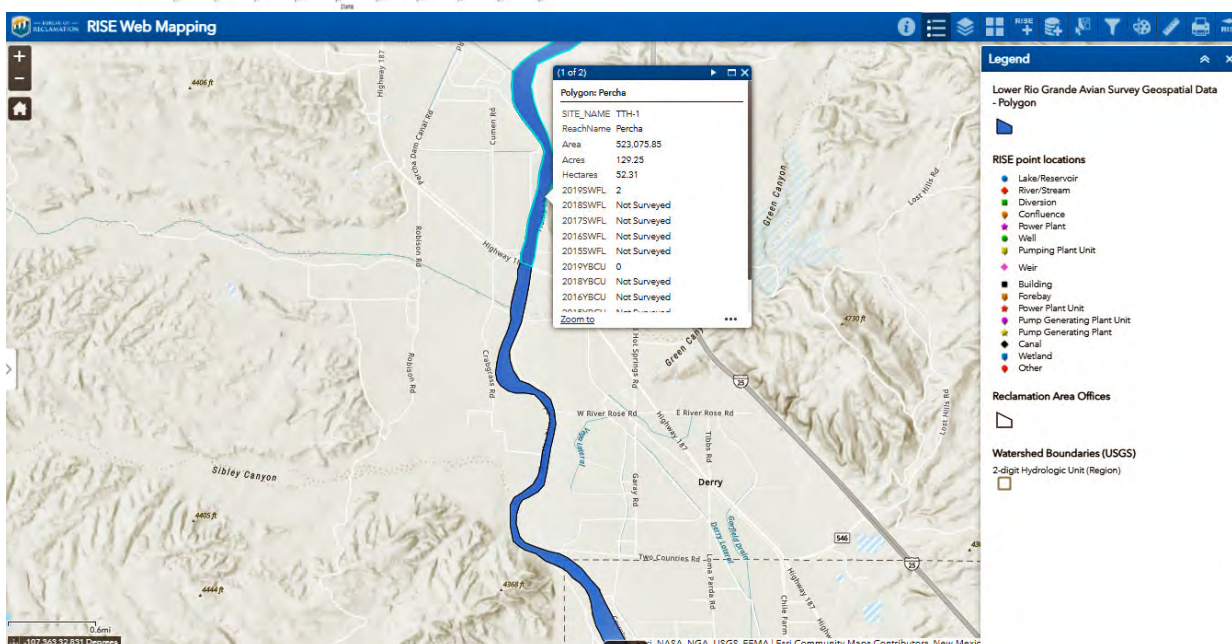
- ◆ **Datasets published in RISE:**  
575 available catalog records as of 9/30/2021
- ◆ **RISE Releases:**  
5 deployments resulting in 127 changes
- ◆ **Average Monthly RISE Users:** 516

a map interface for browsing data by location and interacting with geospatial datasets, a query page for accessing time series data, and an Application Programming Interface (API) for automated data calls. Available datasets include data on water operations, hydropower generation, water quality, invasive and endangered species monitoring, reservoir sedimentation monitoring, S&T research projects, and more.

Also in FY21, Reclamation rechartered the Open Data Team. The goals of the Team are: (1) to reduce potential redundancy of data dissemination activities; (2) to increase efficiency in the use of data dissemination systems by Reclamation staff and stakeholders, (3) to improve program effectiveness and mission fulfillment by promoting the use of open data in decision-making and reporting, and (4) to encourage compliance with the Department of the Interior, Office of Management and Budget (OMB), and statutory requirements related to open data dissemination. The team includes representatives from each region, TSC, Dam Safety and Infrastructure, Information Resources Office, Policy and Programs, Hydropower, and Public Affairs.



Screenshot from RISE, RISE query page showing a plot of reservoir release data.



Screenshot from RISE, RISE map interface.

## Prize Competitions Program

### FY 2021 by the Numbers

- 🔥 6 Competitions Launched
- 🔥 6 Completions
  - 🔥 1 Competitions
  - 🔥 5 Competition completed Phase 1
- 🔥 54 Winning Solutions
- 🔥 \$2,070,000 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 FY2020, Reclamation launched four competitions. Three competitions were launched through Reclamation's relationship with NASA Center of Excellence for Collaborative Innovation (CoECI). These competitions are reaching an international community of solvers and include:

- *Canal Safety Challenge*– seeking to improve public safety and reduce drownings in canals.
- *More Water Less Concentrate Challenge*– seeking to reduce the volume of concentrate and generate more usable water from inland desalination plants.
- *Water America's Crops Challenge: canal seepage reduction*–seeking solutions that can reduce the costs and burdens associated with installation and maintenance of seepage reduction methods, and improve durability in a range of climatic conditions.

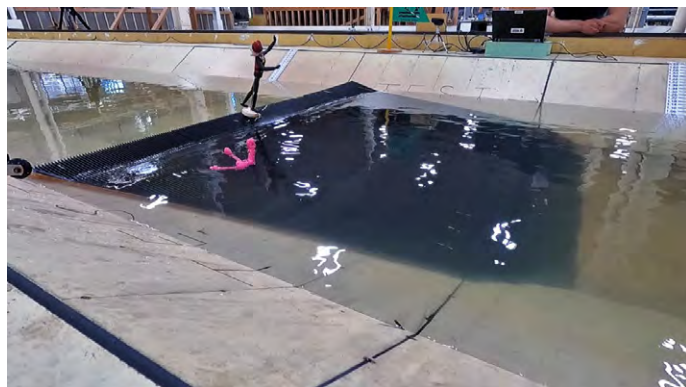


- *Imperfection Detection: Imperfection Detection Challenge*– a portable tool or system for in situ (field) inspection of fiber reinforced polymer (FRP) composite structures (pipes & tanks) that can identify defects or damage accumulated during field service.
- *AMPS Challenge: Automated Maintenance of Protection Systems Challenge*– seeks to automate protection systems testing, eliminate outages necessary to accomplish the testing, and improve hydropower plant reliability.

- *Divide and Conquer: Modeling Large-Scale Hydraulics Faster*– seeking solutions to significantly improve the execution speed of numerical models that simulate hydraulics and sediment transport for rivers and reservoirs.

In FY 2021, one competition concluded and five competitions completed their first phase:

- *Sub-Seasonal Climate Forecast Rodeo 2* – In FY21 \$425,000 in prizes were paid. Overall 61 Winning solutions from around the world shared \$800,000 in prizes.



- *Canal safety Challenge*– three finalists shared \$150,000 and moved to phase 2 (pictured above) for testing their solutions at the Reclamation Technical Service Center's Hydraulics Laboratory in Denver, Colorado.
- *More Water Less Concentrate Challenge*– five teams each received \$115,000, during the next phase submitted prototypes will be tested, and their performance evaluated at Reclamation's Water Quality Improvement Center at the Yuma Desalting Plant in 2022.
- *Guardians of the Reservoir Challenge*– five solvers each received \$75,000 and move to phase 2, where solvers continue developing their solutions and perform a laboratory-scale demonstration of their ideas.
- *Water America's Crops Challenge: canal seepage reduction*– five solvers each received \$50,000 and continue in phase 2 of the competition to develop their idea into a laboratory-scale prototype.
- *Imperfection Detection: Imperfection Detection Challenge*– five solvers shared \$300,000 moved to phase 2 and have 10 months to develop and demonstrate their prototype's performance.

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.

## 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.

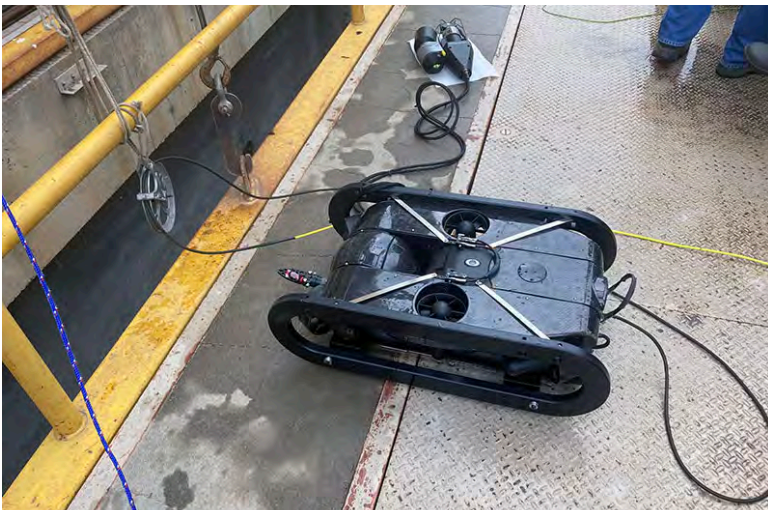
This includes Cooperative Research and Development Agreements (CRADA), Materials Transfer Agreements (MTA), and Facility Use Service Agreements (FUSA), among others, where industry plays a role in maturing and transforming research results into usable, manufactured products that can be supplied to Reclamation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

### TT Activity Summary FY 2021 by the Numbers

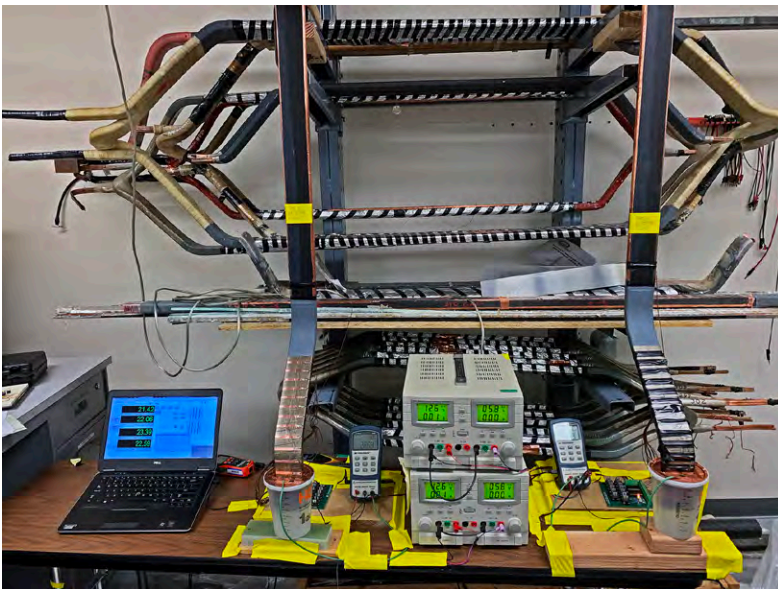
- ◆ 2 CRADAS
- ◆ 6 MTAs
- ◆ 2 Active Patents with License Agreements
- ◆ 0 Patents Filed



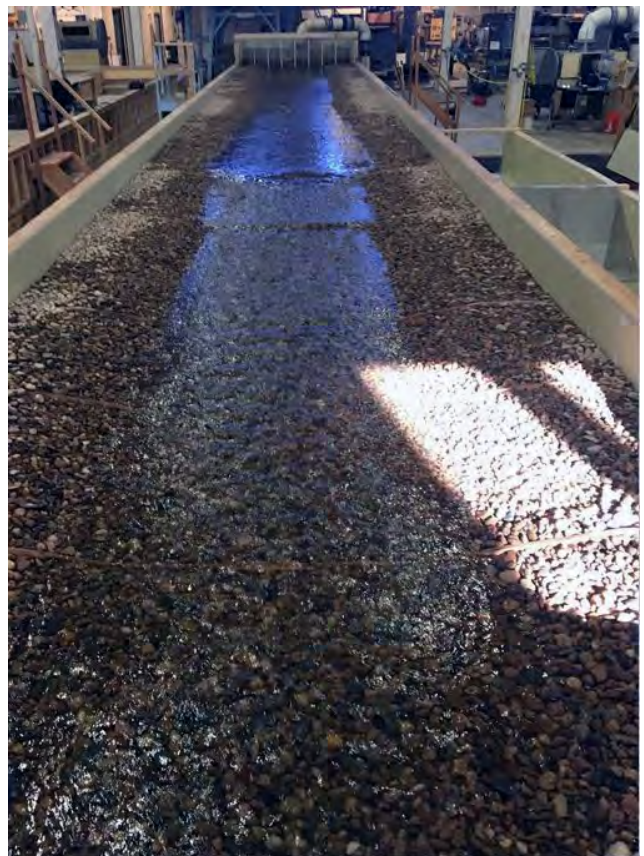
Researchers are partnering with industry to test an automated monitoring device for invasive mussels. (Photo courtesy of ScanLogX)



Remotely Operated Vehicle (ROV) used to inspect Unit G24 at Grand Coulee. (Photo courtesy of GE Renewable Energy)



Two generator stator winding bars being exposed to water and instrumented to detect water absorption.



Example of distorted physical model scaled to a distortion ratio of 2 and successfully provided velocity data for fish passage in urban flood control channels.



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WATER**  
LESS CONCENTRATE

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