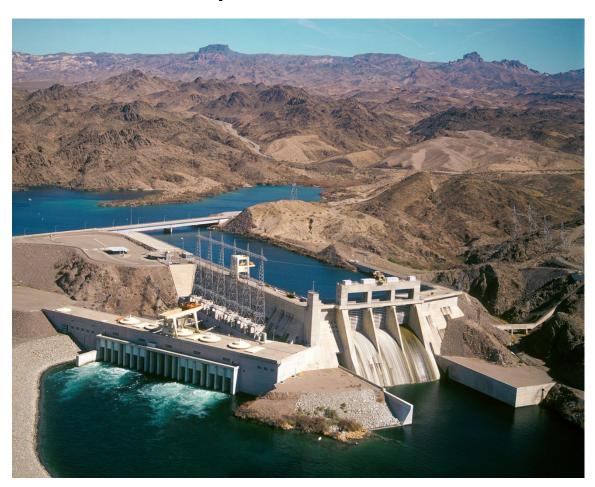# FY 2023 Innovation Strategy Annual Implementation Plan

Science and Technology Program
Research and Development Office

Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Contents

Introduction

To support progress in addressing the research areas and categories identified in the *Science and Technology Program–2022-2025 Innovation Strategy*, this document identifies the specific research needs for each category the Science and Technology Program (S&T) is interested in addressing through research projects during the FY2023 Call for Proposals and for prize competition activities.

Research Roadmaps

Research Roadmaps are an intensive effort to elicit and illuminate the needs within a research category. Roadmapping may be done within a research area, research category, or research needs that requires a deeper dive to discover specifics. These efforts are sponsored by S&T and involve bureau-wide input. Roadmaps typically require six months to one year to complete. Roadmaps can be accessed on this website: https://www.usbr.gov/research/st/needs_priorities/index.html, by clicking on the research area on the menu on the right side of the page. Roadmap links are also provided within this document in the research area or category descriptions.

Regional Director Needs

Each year, prior to the Call for Proposals, S&T solicits Regional Directors for a list of their highest priority research needs for a given year. These needs evolve year-to-year and are published in the annual Call for Proposals. S&T works to be responsive and address these needs by developing a combination of solicited and brokered proposals. For a list of the FY 2023 S&T Program Regional Director Needs, please visit this document.

Partnerships

S&T maintains partnerships with a variety of federal, state, and local government agencies, as well as non-profits, universities, and private entities. During coordination opportunities with these partners, collaborative research opportunities are identified. This allows S&T to share the funding burden of the project and expand the knowledge base contributing to the project.

Prize Competitions

Since 2015, several prize competitions launched and closed with over 750 solutions submitted and 150 winning ideas. Many of the solutions are in the form of idea descriptions or theoretical solutions, that essentially serve as fresh starting points for new research and development activities. Other solutions are more mature and are ready for technology demonstration to further reduction-to- practice.

A summary matrix of the completed prizes and solutions can be viewed here (access to this document is for DOI employees only). Additional prize information can be accessed at https://www.usbr.gov/research/challenges/index.html and by coordinating with the Prize Contact listed in the summary matrix linked above. In the following sections, research needs are identified that are associated with both completed prize competitions and competitions that are ongoing. Researchers with interest in advancing prize solutions from completed competitions are strongly encouraged to coordinate with the Prize Contact listed in the summary matrix linked above and associated Research Coordinator identified below. Research needs that have a prize activity ongoing or completed are noted by a "++" at the end of the description.

Fiscal Year 2022-2025 Science Priorities

The table and narrative descriptions below represent S&T's priority research areas and categories for fiscal year (FY) 2022-2025.

Prize Theme Area	S&T Area	S&T Category
Infrastructure	**Water Infrastructure (WI)**	• Dams • Canals • Pipelines • Miscellaneous Water Infrastructure
	Power and Energy (PE)	• Hydro Powerplants • Pumping Plants • Non-Hydropower Renewable Energy • Energy Efficiency
Environment	**Environmental Issues for Water Delivery and Management (EN)**	• Water Delivery Reliability • Invasive Species • Water Quality* • Sediment Management • River Habitat Restoration
Water	**Water Operations and Planning (WP)**	• Water Supply and Streamflow Forecasting • Water Operations Models and Decision Support Systems • Open Data* • Climate Change and Variability*
	Developing Water Supplies (WS)	• Water Treatment • Water Supply Augmentation • Groundwater Supplies • Agricultural and Municipal Water Supplies • System Losses

Note: Safety is integrated into the Water Infrastructure and Power and Energy S&T areas.
   *Cross-cutting research areas

FY 2023 Research Needs

This section outlines short lists of research needs by research area and category.

Water Infrastructure (WI)

Improve the reliability of Reclamation water storage, water delivery, and facilities by producing or advancing effective solutions, tools, and practices that Reclamation facility managers can use to cost effectively maintain, modernize, and extend the life of Reclamation's aging infrastructure. These should be related to Reclamation's operations and maintenance responsibilities.

Categories:

Dams: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, service life, and safety.

Coordination Contacts
Erin Foraker and Bobbi Jo Merten

Source of Research Needs
[Research Priorities to Enhance Dam Infrastructure Sustainability](#)
Geotechnical Research Roadmap:
https://www.usbr.gov/main/qoi/docs/Geotechnical_Research_Roadmap_FINAL.pdf

Needs Statements

1. Investigate economical, safe, and effective methods to remove medium to large debris accumulating on storage and diversion dam intake structures, in support of budgetary constraints and the increasing wildfires exacerbating the issue in the western states.

2. Investigate methods to detect erosion of material under spillway slabs and into spillway underdrains and materials and methods to repair voids under spillway slabs (cross cutting with Canals), specifically high hazard potential dams which have potential failure modes that are estimated to lie in the low probability, high consequence region of the Dam Safety probability time loss of life ("f-N") chart.

3. Develop modeling tools to predict the rate of deterioration and strength loss in concrete, such as alkali aggregate reaction, freeze thaw, etc.

4. Develop a consistent guideline for seismic analyses of concrete dams which includes advice on input loads for the finite element (FE) analysis techniques and serves as a reference for analysts and dam owners. The guideline would include procedures for calibrating the FE models at different complexity levels and verifying and interpreting the analysis results considering various input parameters.

5. Research innovative design criteria, standards, and materials for new construction or major modifications. Perform historical analyses and "lessons learned" investigations as appropriate.

6. Improve internal erosion risk assessments, including improved methods to model field conditions in a laboratory setting and improved integration of field observations and laboratory testing (cross-cutting with Canals). ++

7. Advance geotechnical laboratory and field testing practices, with emphasis on characterization of cyclic and post-cyclic soil behavior and soil modulus, erodibility of earth materials as related to structure reliability and sediment removal, characterization of engineering properties of gravelly and cobbly soil, and internal erosion (cross-cutting with Canals).

8. Enhance science and engineering to close the gaps between laboratory testing and numerical modeling and between numerical modeling and field performance (cross-cutting with Canals).

Canals: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.

Coordination Contacts
Erin Foraker and Bobbi Jo Merten

Source of Research Needs
[Research Priorities to Enhance Canals Infrastructure Sustainability](#)

Needs Statements

1. Enhanced science and engineering understanding of observations to determine quantifiable thresholds for action, particularly as they relate to risk assessment (cross cutting with Pipelines). Examples include encroachments within or outside right-of-ways, seepage progression, consequences due to failure, or changes due to operations.

2. Evaluate methods and materials to detect and fill or repair voids under canal lining (cross cutting with Dams).

3. Develop underwater canal lining repair materials and methods for cracked, buckled, or bulged linings (underwater crack sealants, grouts, etc.) or underwater canal panel placement material or method.

4. Develop improved, less expensive canal lining, cover, and repair materials and methods.

5. Identify improved inspection methods to reduce siphon pipe failure rates. Less expensive repair methods to repair pipe in lieu of replacement and associated costs (cross cutting with Pipelines).

6. Investigate methods, technologies, or approaches to reduce the incidence of canal drownings by improving physical aspects, sensing, or response techniques ++.

7. Identify economical methods and techniques to improve impacts due to subsidence.

Pipelines: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.

Coordination Contacts
Erin Foraker and Bobbi Jo Merten

Source of Research Needs
[Research Priorities to Enhance Pipeline Infrastructure Sustainability](#)

Needs Statements

1. Improve tunnel condition assessment techniques and repair methods. Determine cost-effectiveness and constructability of alternatives.

2. Investigate non-metallic pipes for large diameter and high-pressure use.

3. Research ROV instrumentation and faster data analysis for evaluating pipe condition assessment, for example coatings and linings, and pipe material, obstructions, and detecting leaks.

4. Demonstrate low- or no-power tools or sensors for detecting or monitoring metallic corrosion when embedded in concrete pipes including prestressed concrete cylinder pipes (cross cutting with Canals).

5. Enhance science and engineering understanding of observations to determine quantifiable thresholds for action, particularly as they relate to risk assessment (cross cutting with Canals). Examples include pipe leaks, consequences due to failure, or changes due to operations.

Miscellaneous Infrastructure: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, and service life.

Coordination Contacts
Erin Foraker and Bobbi Jo Merten

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Data standards - Evaluate standardized data collection approaches for inspections to facilitate improved data processing or predictive or condition-based maintenance. Develop approaches to better document as-built conditions at time zero, i.e., baseline conditions.

2. Data processing and access - Develop solutions, tools, and practices to improve analysis of large datasets, such as from photogrammetry or other detection methods, including 3D data visualization. Improve data accessibility and streamline design processes through incorporation of real-time data. ++

3. Predictive maintenance - Research machine learning, artificial intelligence, algorithms, or other solutions to develop a predictive or condition-based maintenance approach for assets (cross cutting with Power and Energy). ++

4. Safety - Research projects that focus on improving the safety of the public and Reclamation personnel and operations, including but not limited to, robotics, improved hearing protection, improved hazardous energy detection, and monitoring and preventing repetitive stress and exposure related injuries and occupational illnesses.

5. Security-Develop solutions, tools, and practices to further Reclamation's understanding of current or developing threat tactics and security risks related to emerging technologies. The research should result in data and conclusions that can be integrated into Reclamation's security program to provide Reclamation with an enhanced capability to evaluate and manage risk at its critical infrastructure. For additional details regarding security related research needs, [please reference this document](#).

Power and Energy (PE)

Improve safety, reliability, resiliency, and efficiency by developing or advancing operations and maintenance and regulatory compliance solutions, tools, and practices of Reclamation's hydropower, pumping, and pump-storage facilities in order to reduce costs and increase energy supplies, and add value, ensuring Reclamation's hydropower remains a long-term, cost-competitive energy resource with quickly changing energy markets.

Categories:

Hydro Powerplants: Examine, develop, and deploy tools, methods, practices, and strategies to improve safety, operations and maintenance, reliability, efficiency, outage time, and output, including pump-storage plants.

Coordination Contact
Erin Foraker

Source of Research Needs
For additional details regarding hydropower protection system related research needs, please reference the [Research Priorities for Mechanical Components of Hydropower Units](#) and the [FY 2021 Call PE General Needs document](#).

Needs Statements

1. Hydro Increase hydropower equipment reliability and performance for the hydroelectric generation powertrain from water to wire, including but not limited to, generator insulation systems, excitation, control, maintenance strategies, Supervisory Control and Data Acquisition (SCADA), and machine condition monitoring—such as to develop or improve existing tools to recommend effective operational limits that can distinguish erosive (damaging/ metal or material loss) cavitation from non-erosive cavitation.

2. Develop and implement new data science techniques to reduce cost, improve reliability, and increase efficiencies (cross cutting with Water Infrastructure Section).

3. Improve safety and occupational health, including but not limited to, monitoring and preventing repetitive stress and exposure related injuries and occupational illnesses, including but not limited to, rotating machines and personal protective grounding methods (cross cutting with Water Infrastructure Section).

4. Evaluate, investigate, and develop less invasive and labor-intensive maintenance tasks or automated techniques, e.g., new sensor technologies, data sampling strategies, system integration, digitization, and data science tools, related to hydropower protection and control systems, excitation and governor systems, and other hydropower equipment, i.e., Maintenance Improvement Initiatives.

5. Develop methods to authenticate and improve hydropower value to support sustainable, cost-competitive hydropower resource within quickly-changing energy markets, including but not limited to, new energy storage technologies and evaluation of ancillary services.

6. Improve materials or find alternative techniques for preventing corrosion, cavitation, and erosion damage that are cost effective, minimize outage time, and are durable and repairable, including but not limited to, coatings in high velocity environments, coating application in low temperatures and humid or wet conditions, and cavitation repair methods for turbine runners.

7. Develop inspection tools that advance data quality and reduce costs and time for inspecting equipment with limited access, identify alternatives for inspections and operational tests that cannot easily be performed, including but not limited to, large pipes and penstocks with difficult-to-access or dangerous geometries (e.g., complex geometry, steep slopes, drops, etc.), submerged equipment (e.g., bulkheads, trashracks, gates, valves, etc.), and auxiliary systems (e.g., cooling water; heating, ventilation, and air conditioning [HVAC]; fire protection; oil piping, and other auxiliary equipment systems).

8. Investigate best practices for mitigating generator rotor arm cracking, rotor rim float, and pole connection failure issues.

9. Improve equipment shaft, bearing, and seal reliability, including but not limited to, oil level measurement accuracy and robustness for unsteady oil reservoir depths, hydraulic conditions, or difficult applications during unit operation, oil quality standards and performance (viscosity, temperature, moisture, contaminants), and oil containment and leak detection for different oil systems, and greaseless technologies and environmentally friendly lubricants.

Pumping Plants: Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, and outage time.

Coordination Contact
Erin Foraker

Source of Research Needs
[Research Priorities to Enhance Pumping Plant Infrastructure Sustainability](#)

Needs Statements

1. Improved pump operation and maintenance, including but not limited to, monitoring techniques related to pump starts, improved philosophy to ensure long term sustainability, and identify, demonstrate, and enhance pump storage attributes that make it a cost-effective utility scale option for grid energy storage that supports an increasing amount of variable generation.

2. Investigate nondestructive inspection tools, such as ultrasonic testing, to improve efficiency and effectiveness of inspections in hard to access areas, and research and develop longer service life interior pipe coatings (cross-cutting with Hydropower Plants).

3. Evaluate pump economics, including by not limited to, investigate the economics of repairing versus replacing pumps and pump impellers (Reclamation's Technical Service Center [TSC] has a pumping plant assets inventory data file); investigate the economics of variable frequency drives regarding operational parameters, equipment and installation costs, and future utility costs; identify and modify machine condition monitoring techniques used for powerplants to be applicable for pumping plants, investigate composite materials for intake equipment, such as structural fiberglass, including lifecycle cost and benefit-cost analyses.

4. Vibration testing of exposed pipe in pump discharge basins (not in roadmap).

Non-Hydropower Renewable Energy: Examine and develop tools, practices, and strategies for generating and using non-hydro renewable energy within Reclamation including solar, wind, geothermal, other forms of non-hydro renewable energy, storage, and hydropower and NHRE system support.

Coordination Contact
Erin Foraker

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Identify and develop facility scale solar training strategies to facilitate the use of solar PV at Reclamation facilities where feasible.

2. Develop expert resources to perform renewable energy assessments and assist with requests for proposals related to solar PV at Reclamation's facilities.

3. Identify and develop detailed assessments and reports of the impacts of solar PV over Reclamation water bodies.

4. Evaluate energy storage (not pump-storage) opportunities when paired with hydropower and other forms of renewable energy.

Energy Efficiency: Examine and develop tools, methods, practices and strategies to improve energy efficiency at Reclamation buildings and non-hydropower facilities.

Coordination Contact
Erin Foraker

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Explore new technologies and approaches to conduct to improve energy efficiency audits by experts and identify facility specific conservation and efficiency measures.

2. Develop, identify, and educate Reclamation personnel on best practices to achieve facility resilience, including energy and water conservation best practices, zero energy and zero water buildings.

3. Develop a methodology to maximize energy efficiency improvements prior to solar photovoltaic (PV) installations.

Environmental Issues for Water Delivery and Management (EN)

Improve the reliability of Reclamation water deliveries by producing effective solutions, tools, and practices that Reclamation water managers can use to carry-out Reclamation's mission in an environmentally sound manner.

Categories:

Water Delivery Reliability: Improve the reliability of Reclamation water supplies by finding innovative means to address aquatic and terrestrial ecosystem and species needs while still meeting water delivery contracts.

Coordination Contact
Lindsay Bearup

Source of Research Needs
[Environmental Issues for Water Delivery and Management Research Roadmap](#)

Needs Statements

1. Operations strategies for flow hydrographs to improve ecological resiliencies (e.g., ecosystems, groundwater recharge, biodiversity).

2. Quantify ecosystem services related to environmental flows.

3. Operation strategies to reduce stranding of aquatic organisms during low and high flows.

Invasive Species: Explore the impacts of invasive and pest species on Reclamation's infrastructure for water supplies and deliveries, and harm to threatened or endangered species, through the development and improvement of techniques for the prevention, early detection, monitoring, and control of invasive and pest species in Reclamation's service area.

Coordination Contact
Sherri Pucherelli

Source of Research Needs
[Invasive Mussel Research Roadmap, Environmental Issues for Water Delivery and Management Research Roadmap](#)

Needs Statements

1. Prevention

   a. Optimize invasive/ pest species prevention methods such as watercraft inspection and decontamination (WID), by developing vector modeling to prioritize WID locations.

   b. Develop technologies to prevent the transport of invasive species from one location to another.

   c. Investigate the risks of canal systems transporting aquatic invasive/ pest species.

2. Early detection and monitoring

   a. Develop invasive species risk assessments to prioritize monitoring and other efforts by increasing knowledge and understanding of factors that limit or promote establishment and population growth including climate change.

   b. Optimize existing sample collection and analysis methods, and develop new methods for invasive/ pest species detection, including molecular methods and automation.

   c. Develop monitoring protocols to apply to rapid response scenarios and to assess efficacy of control/ eradication efforts.

   d. Investigate new methods for remote, rapid detection and mapping of terrestrial invasive/ pest species.

   e. Develop a tool or database of invasive species occurrence on Reclamation managed lands and waters, including information about integrated pest management (IPM) strategies and NEPA documents.

3. Control

   a. Evaluate and develop target specific control methods including chemical, biological, and genetic control options for the management of invasive/ pest species.

4. Impact assessment

   a. Increase the knowledge and understanding of ecological and economic impacts of invasive species in the western United States.

   b. Investigate how climate change will influence invasive/ pest species invasion patterns, probability of establishment, and potential impacts on Reclamation assets.

Water Quality: Develop and advance tools and practices that Reclamation has the mission responsibility and authority to use in managing water quality issues that are (1) linked to reclamation operations and (2) could impact the reliability of Reclamation water deliveries if not addressed.

Coordination Contact
Mike Horn

Source of Research Needs
[Environmental Issues for Water Delivery and Management Research Roadmap](#)

Needs Statements

1. Improve understanding of operational effects on water quality in flow releases, and in-reservoir processes.

2. Develop or improve methods to predict, manage, and monitor effects of hydrologic variability on water quality.

3. Understand impacts of external anthropogenic influences such as fires on reservoir water quality

4. Techniques to mitigate water quality impacts in reservoirs, releases into downstream rivers, hydropower plants, or wetlands

5. Strategies to prevent, monitor or treat harmful algal blooms

Sediment Management: Develop and improve sediment management solutions and tools that improve the reliability and sustainability of water deliveries from Reclamation reservoirs and associated river systems and improve habitat conditions for threatened and endangered species.

Coordination Contact
Jennifer Bountry

Source of Research Needs
[Environmental Issues for Water Delivery and Management Research Roadmap](#)

Needs Statements

1. When augmenting sediment downstream of dams, improve monitoring methods to track sediment below reservoirs and better understand downstream channel morphology and habitat complexity response.

2. Improve capability of numerical models to predict responses from sediment management options in reservoirs.

3. Develop indirect methods to estimate reservoir sedimentation. ++

4. Develop more cost-effective methods for removing sediment in reservoirs to maintain or increase lost storage. ++

5. Improve quantification tools for estimating effects from large scale fires on sediment production and associated river morphology or reservoir sedimentation response. Applies to water quality impacts (e.g., turbidity) from fires as well.

River Habitat Restoration: Develop and improve aquatic habitat management solutions and tools that improve the ability to comply with regulatory requirements or mitigation measures assigned to Reclamation programs including channel improvements, floodplain connectivity, channel complexity, fish passage and protection, and riparian vegetation enhancement.

Coordination Contact
Connie Svoboda

Source of Research Needs
Environmental Issues for Water Delivery and Management Research Roadmap

Needs Statements
1. Develop alternatives to improve fish screen performance or that eliminate the need for fish screens.++
2. Improve understanding of methods to address upstream and downstream fish passage ++
3. Improve understanding of species survival through large river systems.
4. Improve detection and tracking of movement and migration of individuals and/or species
5. Evaluate post-construction performance of rehabilitation projects through engineering and fisheries assessments.
6. Better understand effects of ecohydraulics on habitat availability, connectivity, and food webs for species of concern.
7. Improved understanding and confidence in the ability of numerical and physical models to represent field condition hydraulics surrounding in-channel habitat features.

Water Operations and Planning (WP)

Develop solutions and tools that help Reclamation water managers make effective reservoir and river system operational and planning decisions. Improve the integration, evaluation, understanding, and presentation of critical data and information.

Categories:

Water Supply and Streamflow Forecasting: Develop and improve solutions and tools to forecast and monitor water supplies, including hydrologic events, and water demands.

Coordination Contact
Ken Nowak

Source of Research Needs
[Short Term Water Management Decisions](#)

Needs Statements

1. Develop techniques to extend or improve skill of temperature and precipitation forecasts at the seasonal time frame.++

2. Investigate new technologies and methods for monitoring/modeling snowpack conditions (e.g., snow water equivalent [SWE], snow depth, and snow extent) to improve water supply forecast skill. This may include investigations for new measurement technologies (e.g., satellite and building capacity for working with such data), processing or modeling of datasets, and evaluation of water supply forecast skill improvement.

3. Develop techniques and workflows to automate data acquisition and usage in response to increasing forecast frequency and decreasing latency.

4. Enhance and evaluate emerging short-term streamflow forecasting methods, including their benefit to operational decision making. ++

5. Explore and develop methods to improve projected/forecasted impact of diversions/depletions on reservoir inflows.

6. Explore and develop practices and workflows for developing and/or using forecast hindcasts in modeling/planning activities.

Water Operations Models and Decisions Support Systems: Develop and improve reservoir/river system operations and planning models and decision support systems in order to optimally manage water delivery and use for Reclamation. This would include investigations and methods for water supply losses through evaporation.

Coordination Contact
Ken Nowak

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Develop approaches and tools to support and maximize real-time operations in response to competing objectives and other constraints.

2. Develop approaches and tools to support efficient evaluation of benefits (e.g., economic) associated with new forecast products and/or operational paradigms (i.e., a testbed).

3. Develop or explore decisions support tools and operational paradigms that leverage or pair with ensemble forecast products.

4. Explore opportunities for improved planning and operations that can leverage increasing access to high performance computing resources.

5. Explore opportunities to link or better integrate models and decision support systems with related models (e.g., operations, hydropower, sediment, and water temperature).

6. Develop decision support methods for reservoir operations that consider both short-term streamflow and seasonal water supply forecast information in meeting operational objectives.

Open Data: Develop methods and tools to improve management of Reclamation's water and related data to make it more comparable across locations, more easily found, and more shareable, both within Reclamation and with other agencies, stakeholders, and the public. This includes expanding applicability and use of the Reclamation Information Sharing Environment (RISE, available at https://data.usbr.gov/), a platform for publishing Reclamation's mission-related data.

Coordination Contact
Allison Odell

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Develop and demonstrate tools that leverage RISE data and could be hosted on the RISE visualization server to enhance decision support frameworks and information visualization in support of engagement, communication, and collaboration amongst Reclamation customers, stakeholders, other agencies, and the general public.

2. Investigate methods to facilitate adoption and expand utilization of RISE and/or contribute to expanding RISE data publication capabilities. This may include investigation of methods for publishing data types that are not currently represented in RISE (e.g., large, complex, multi-dimensional, or novel datasets) or for which RISE could provide better data services. This could also include development of data standards, data formatting tools, or data management methods to enable or expand compatibility with the RISE system.

3. Identify and evaluate how emerging technologies and trends related to data discovery, integration, and use, such as enhanced metadata and learning algorithms (e.g., web 3.0, semantic web, natural language processing, machine learning, etc.), can be effectively applied in Reclamation data management and dissemination.

Climate Change and Variability: Develop methods and tools to increase adaptive management and flexibility in the planning, design and operations of Reclamation's facilities in a variable and changing climate, including management of droughts and floods.

Coordination Contact
Ken Nowak

Source of Research Needs
[Addressing Climate Change in Long Term Water Resources Planning and Management](#)
Needs Statements

1. Develop tools and resources to support informed use of climate model projections in water management applications.

2. Develop methods and basis for estimating extreme meteorological and hydrologic event possibilities, deterministically or probabilistically, in a changing climate.

3. Identify risks posed by climate change and extreme weather, to efficient and continuous operation of water and power infrastructure, and potential adaptation strategies.

4. Develop tools, methods, or resources for assessing observed climate change and how to appropriately consider historical data, including paleo reconstructed data, in planning, maintenance, operations, and other aspects of Reclamation's mission.

5. Explore and develop climate change adaptation techniques and tools that focus on understanding system vulnerability and resilience (e.g., DMDU [Decision Making Under Deep Uncertainty], decision scaling, etc.).

Developing Water Supplies (WS)

Develop, enhance, and protect water supplies for Reclamation stakeholders with new technologies, solutions, and practices that expand, create, or conserve water supplies.

Categories:

Water Treatment: Develop technologies, methods, tools and approaches to advance the treatment of impaired water sources that allow Reclamation to better utilize existing supplies or develop new supplies from non-traditional water resources such as brackish groundwater, seawater, municipal wastewater, produced waters from oil and gas extraction activities, and other impaired sources.

Coordination Contact
Yuliana Porras-Mendoza

Source of Research Needs
[Advanced Water Treatment Research Roadmap](#)

Needs Statements

1. Concentrate:
   a. Investigation of concentrate residual waste disposal option including mass, volumes, beneficial reuse, selective precipitation
   b. Develop and evaluate technologies such as novel membrane processes, nonsteady-state membrane processes, enhanced evaporation, advanced thermal processes in order to reduce concentrate volume
   c. Management challenges of concentrate from water reuse treatment
   d. Sparingly soluble inorganic removal/management to increase water recovery
   e. Silica removal/management to increase recovery
   f. Onsite acid/base generation from concentrate

2. Decentralized systems:
   a. Integrating renewable energy to power off-grid water treatment, including desalination

3. Decision support tools research category:
   a. Development of metrics and tools for comparing/evaluating technologies
   b. Create a water reuse technology primer

4. Pollutant/Constituent Removal:

   a. Developing and/or optimizing existing technologies or processes for the characterization, detection, monitoring and sensing of Contaminants of emerging concern (CEC) and per/poly-fluoroalkyl substances (PFAS)

   b. Develop and/or optimize technologies focused on the destruction of CEC and PFAS

   c. Develop and/or optimize technologies for the separation and treatment of groundwater and surface water with CEC and PFAS

5. Water reuse research:

   a. Develop non-reverse osmosis-based technologies and treatment trains for non-potable and potable reuse

   b. Develop and optimize membrane-based technologies and treatment trains for non-potable and potable reuse

6. System optimization research:

   a. Sensor development to support system optimization
      i.   Real-time fouling/scaling feedback
      ii. System upsets (where in the system)
      iii. Internet of things (IOT)
      iv. Troubleshooting in real-time

7. Treatment processes research:

   a. Evaluating and developing a new class of membrane materials to lower energy requirements, increase recovery, and improve separations

   b. System optimization through artificial intelligence

Water Supply Augmentation: Develop and improve processes, resources, and/or technologies to augment water supplies for Reclamation projects by utilizing water sources such as stormwater; natural treatment systems such as wetlands; or management approaches such as cloud seeding or hydrologic investigations.

Coordination Contact
Yuliana Porras-Mendoza

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Research to understand winter orographic cloud seeding effectiveness and impacts.

2. Identify needs where natural treatment systems such as wetlands can be utilized for water supply augmentation

3. Identify needs and challenges for the use of stormwater across the western United States to be utilized for water supply augmentation

Groundwater Supplies: Develop and improve solutions and tools that advance and optimize groundwater supplies for either storage and/or further understanding of surface water impact on groundwater supplies that can be of use for Reclamation projects. Projects under this category should not focus on the treatment of groundwater, these type of projects belong under the water treatment category

Coordination Contact
Jennifer Johnson and Ken Nowak

Source of Research Needs
Brackish Groundwater in the United States and Ongoing Research Needs: Groundwater-Surface Water Interaction

Needs Statements

1. Groundwater quality data needs
   a. Occurrence and distribution of groundwater
   b. Hydrogeologic characterization.
   c. Geochemistry
   d. Brackish groundwater use.
   e. Brackish groundwater sustainability

2. Groundwater-surface water interaction

   a. Summarize relevant data and overcoming data gaps

   b. Models and processes used to evaluate groundwater-surface water interaction in regulated river systems

Agricultural and Municipal Water Supplies: Develop and improve technologies, methods, tools, and approaches to augment water supplies for agricultural and municipal water demands at a lower cost and mitigating environmental impact for Reclamation stakeholders and projects.

Coordination Contact
Yuliana Porras-Mendoza

Source of Research Needs
There is no research roadmap currently available for this category.

Needs Statements

1. Decision support tools development for comparing and evaluating technologies treating agricultural drainage water

2. Process development for selective constituent removal and recycle/reuse of agricultural drainage water

3. Evaluation and planning guidance tools on how to augment water supplies from the treatment/reuse of agricultural drainage water

Water Losses: Develop and improve processes, technologies, and tools that conserve water and/or reduce water losses in Reclamation water storage and delivery systems.

Coordination Contact
Yuliana Porras-Mendoza

Source of Research Needs

There is no research roadmap currently available for this category.

Needs Statements

1. Improve evaporation measurement technology that is necessary to evaluate the efficacy of evaporation suppression technologies.

2. Improve evaporation measurement data management at Reclamation reservoirs and evaluate the impact of the sustained water loss.

3. Develop new and innovative ways to reduce the loss of water via evaporation at reservoirs and optimize systems to maintain water at Reclamation reservoirs in order to meet water delivery requirements.