BUREAU OF RECLAMATION

FY 2021 Science Strategy Annual Implementation Plan

Science and Technology Program
Research and Development Office

U.S. Department of the Interior

April 2020

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

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

1. Introduction

To support progress in addressing the research areas and categories identified in the *Science and Technology Program – Strategic Science Priorities – FY 2018-FY 2021*, 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 FY2021 call for proposals.

1.1 How are Research Needs and Projects Identified?

The S&T Program contributes to the *Presidential Memorandum on Promoting the Reliable Supply and Delivery of Water in the West*:

Sec. 4: Improve Use of Technology to Increase Water Reliability

1. promote expanded use of technology for improving the accuracy and reliability of water and power deliveries

2. invest in programs that promote and encourage innovation, research and development of technology that improve water management.

3. invest in technology to enable broader deployment of desalination and recycled water technologies

Sec. 3: Improve Forecasts of Water Availability

1. facilitate greater user of forecast-based management

2. improve the information and modeling capabilities related to water availability and water infrastructure projects.

1.2 Department of the Interior Policies

S&T works to ensure its priorities align with Reclamation's mission and the Department of Interior's Strategic Plan. In addition, the Department has released priorities with the applicable ones listed below.

1. Creating a conservation stewardship legacy second only to Teddy Roosevelt

    a. Utilize science to identify best practices to manage land and water resources and adapt to changes in the environment.

    b. Examine land use planning processes and land use designations that govern public use and access.

    c. Revise and streamline the environmental and regulatory review process while maintaining environmental standards.

    d. Review DOI water storage, transportation, and distribution systems to identify opportunities to resolve conflicts and expand capacity.

    e. Foster relationships with conservation organizations advocating for balanced stewardship and use of public lands.

    f. Identify and implement initiatives to expand access to DOI lands for hunting and fishing.

    g. Shift the balance towards providing greater public access to public lands over restrictions to access.

2. Utilizing our natural resources

    a. Ensure American Energy is available to meet our security and economic needs.

    b. Ensure access to mineral resources, especially the critical and rare earth minerals needed for scientific, technological, or military applications.

    c. Refocus timber programs to embrace the entire 'healthy forests' lifecycle.

    d. Manage competition for grazing resources.

3. Restoring trust with local communities

    a. Be a better neighbor with those closest to our resources by improving dialogue and relationships with persons and entities bordering our lands.

b. Expand the lines of communication with Governors, state natural resource offices, Fish and Wildlife offices, water authorities, county commissioners, Tribes, and local communities.

4. Striking a regulatory balance

    a. Reduce the administrative and regulatory burden imposed on U.S. industry and the public.

    b. Ensure that Endangered Species Act decisions are based on strong science and thorough analysis.

5. Modernizing our infrastructure

    a. Support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure.

    b. Remove impediments to infrastructure development and facilitate private sector efforts to construct infrastructure projects serving American needs.

    c. Prioritize DOI infrastructure needs to highlight:
        i. Construction of infrastructure.

        ii. Cyclical maintenance.

        iii. Deferred maintenance.

1.3 Reclamation Priorities

The S&T Program also supports Reclamation's current priorities.

1. Increase Water Supplies, Storage, and Reliability under WIIN and other Authorities to Benefit Farms, Families, Businesses, and Fish and Wildlife[1]

2. Streamline Regulatory Processes and Remove Unnecessary Burdens to Provide More Water and Power Supply Reliability[2]

3. Leverage Science and Technology to Improve Water Supply Reliability to Communities[3]

4. Address Ongoing Drought on the Colorado River

5. Improve the Value of Hydropower to Reclamation Power Customers

6. Improve Water Supplies for Tribal and Rural Communities

7. Implementation of new Title Transfer authority pursuant to P.L. 116-9

1.4 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.

1.5 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 2021 S&T Program Regional Director Needs, please visit this document.

1.6 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.

1.7 Prize Competitions

Since 2015, several prize competitions launched and closed with over 350 solutions submitted and 50 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 associated with completed prize competition are designated with a ++ symbol. Researchers with interest in advancing prize solutions are recommended to coordinate with the Prize Contact and associated Research Coordinator identified below.

2. Fiscal Year 2018-2021 Science Priorities

The table and narrative descriptions below represent S&T's priority research areas and categories for fiscal year (FY) 2018-2021.

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

**Cross-cutting research areas*

3. FY 2021 Research Needs

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

3.1 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.

3.1.1 Dams

Description
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

Needs Statements

1. Methods and materials to detect and fill or repair voids under spillway slabs (cross cutting with Canals), specifically in low probability, high consequence scenarios like Oroville Dam.

2. Modeling tools to predict the rate of concrete deterioration, including alkali aggregate reaction.

3. Develop a consistent guideline for seismic analyses of concrete dams that integrates the seismic input loads with the FE analysis techniques and serves as a reference for analysts and dam owners. In a guideline, a methodical process would be developed together with the procedures for calibrating the FE models at different complexity levels and verifying and interpreting the analysis results considering various input parameters.

3.1.2 Canals

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

Coordination Contacts
Erin Foraker and Bobbi Jo Merten

Source of Research Needs
Research Priorities to Enhance Canals Infrastructure Sustainability

Needs Statements

1. Enhanced methods for rehabilitation and maintenance of urbanized canals and immediate response systems for changes to these canals.

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

3. 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. Improved, less expensive canal lining, cover, and repair materials and methods.

5. 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.

3.1.3 Pipelines

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

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.

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

3. Better ROV instrumentation and faster data analysis for evaluating pipe coatings, including film thickness, and pipe body metallic pipe deficiencies, detecting leaks, and faster data analysis.

4. Identify or evaluate cost-effectiveness and constructability of alternatives to pressure grouting for tunnels.

5. 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).

3.1.4 Miscellaneous Infrastructure

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

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 maintenance.

2. Data processing - Develop solutions, tools, and practices to improve analysis of large datasets, such as from photogrammetry or other detection methods.

3. Predictive maintenance - Research machine learning, artificial intelligence, algorithms, or other solutions to develop a predictive maintenance approach for assets.

4. Safety - Research projects that focus on improving the safety of Reclamation personnel, such as robotics, improved hearing protection, improved hazardous energy detection, etc.

5. Security - Develop solutions, tools, and practices to further Reclamation's understanding of security risks at its facilities using qualitative and quantitative data. 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.

3.2 Power and Energy (PE)

Develop and advance solutions, tools, and practices that improve the reliability, efficiency, and safety of Reclamation's hydropower and pumping facilities in order to reduce costs and increase energy supplies.

3.2.1 Hydro Powerplants

Description
Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, outage time, and output.

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. Hydropower generation
    a. Improves safety and occupational health.

    b. Increases reliability, power generation, and performance.

    c. Improves operations and maintenance practices.

    d. Examines new operations and maintenance philosophies, such as new sensor technologies, data sampling strategies, and analytical systems.

2. Protection systems
    a. Test method improvements.

    b. Less invasive protection system test methods for all aspects of the protection system including current transformers (CT) / potential transformers (PT), protective relays, lockout relays, and associated wires and equipment.

    c. Broad approaches to improvements, which minimize outage periods, reduce Operation and Maintenance (O&M) costs, improve reliability and protection, etc.

    d. Online monitoring of protection equipment.

    e. Environmentally friendly lubricants - Determine the applicability and longevity of greaseless technologies and environmentally friendly lubricants to Reclamation's powerplant operations.

3. Mechanical equipment - penstocks
    a. Improve durability and extend service life for coatings materials in high-velocity environments.

    b. Improve coating materials for application in low temperature and humid conditions.

c. Develop or advance inspection and coating application and repair methods for large pipes and penstocks with difficult-to-access or dangerous geometries (e.g., complex geometry, steep slopes, drops, etc.). Inspection methods should improve data quality and reduce inspection time.

4. Mechanical equipment - gates and valves
    a. Improve durability and extend service life for coatings materials in locations prone to high velocity, erosion, and cavitation.

    b. Develop or improve inspection methods for submerged equipment (e.g., bulkheads, trashracks, gates, valves, etc.). Inspection methods should improve data quality and reduce inspection time.

    c. Consider alternative materials or techniques to improve corrosion protection for existing structures and equipment.

5. Mechanical equipment - turbine runner and wicket gates
    a. Develop or improve existing tools to recommend effective operational limits that can distinguish erosive (damaging/ metal or material loss) cavitation from non-erosive cavitation.

    b. Integrate detection tools into existing Supervisory Control and Data Acquisition (SCADA) or monitoring systems.

    c. Improve cavitation repair methods for turbine runners that are cost effective, minimize outage time, and are durable and repairable.

6. Mechanical equipment – auxiliaries
    a. Consider alternative materials or techniques to improve corrosion protection for auxiliary systems.

    b. Improve or advance inspection methods for auxiliary systems (e.g., cooling water; heating, ventilation, and air conditioning [HVAC]; fire protection; oil piping, and equipment systems). Inspection methods should improve data quality and reduce inspection time.

7. Mechanical equipment - generators
    a. Compile information on best practices or guidelines on rotor cracking and loose poles from industry.

8. Mechanical equipment - shafts and bearings
    a. Improve oil level measurement accuracy and robustness for unsteady oil reservoir depths, hydraulic conditions, or difficult applications during unit operation.

    b. Identify or consolidate information for oil quality standards (viscosity, temperature, moisture, contaminants) and performance in Reclamation's powerplants.

c. Consolidate information on oil containment and leak detection for different oil systems.

d. Environmentally friendly lubricants - Determine the applicability and longevity of greaseless technologies and environmentally friendly lubricants to Reclamation's powerplant operations.

3.2.2 Pumping Plants

Description
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. Buried and encased pipe
    a. Research and develop longer service life interior pipe coatings that can be applied at low temperatures and high humidity.

    b. Review and reassess uses of non-corrosive materials, such as polyvinyl chloride, for buried and encased pipe.

2. Investigate nondestructive inspection tools, such as ultrasonic testing, to improve efficiency and effectiveness of inspections in hard to access areas.

3. Pump economics
    a. Investigate the economics of repairing versus replacing pumps and pump impellers (the Bureau of Reclamation's [Reclamation] Technical Service Center [TSC] has a pumping plant assets inventory data file).

    b. Investigate the economics of variable frequency drives regarding operational parameters, equipment and installation costs, and future utility costs (high power factor).

    c. Identify and modify machine condition monitoring techniques used for powerplants to be applicable for pumping plants.

    d. 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).

3.2.3 Energy Efficiency

Description
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 PV installations.

3.2.4 Non-Hydropower Renewable Energy

Description
Examine and develop tools, practices, and strategies for generating and using non-hydro renewable energy within Reclamation including solar, wind, geothermal, and other forms of non-hydro renewable energy.

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 RFPs related to solar PV at Reclamation's facilities.

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

3.3 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 address state and federal environmental compliance and court orders.

3.3.1 Water Delivery Reliability

Description
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. Develop best practices to implement adaptive management for operations to support environmental restoration.

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

5. Non-hazardous tools or methods to control or prevent woody vegetation on unlined canal embankments.

3.3.2 Invasive Species

Description
Develop and improve techniques for prevention, early detection and monitoring, control, and for determining the impacts of invasive species that consume Reclamation water supplies, impede Reclamation water deliveries, or harm threatened or endangered species.

Coordination Contact
Sherri Pucherelli

Source of Research Needs
Environmental Issues for Water Delivery and Management Research Roadmap, DOI: Safeguarding America's Lands and Waters From Invasive Species, Dreissenid Mussel Research Priorities Workshop, Quagga-Zebra Mussel Action Plan for Western U.S. Waters

Needs Statements

1. Prevention
    a. Identify vector factors that have a significant potential to introduce invasive species to unaffected water-ways (e.g. types of watercraft, types of motors, construction equipment etc.) and develop effective methods to reduce the probability of new infestations.

    b. Develop new construction designs and modifications to existing structures that improve their ability to prevent and control invasive species infestations for long-term control.

2. Early detection and monitoring
    a. Establish informative biotic and abiotic metrics, including factors associated with water management and past/present detection results to assess the potential for invasive species presence, growth, and reproduction.

    b. Develop a standardized model and strategy for invasive species risk assessments to prioritize and direct sample collection protocols and detect invasive species at an early stage, including water body/site selection and scheduling based on temporal variables.

    c. Develop emerging and optimize existing methods for invasive species detection, including sample collection and analysis, molecular methods, or others.

3. Control
    a. Identify and develop biological control options including genetic controls for open-water management of invasive species.

    b. Develop closed-water system control tools, including mechanical and physical control options for use in enclosed pipe systems.

    c. Develop target specific, environmentally-friendly control methods.

4. Impact assessment
    a. Determine ecological and economic impacts of invasive species in the western United States.

    b. Estimate impacts to the life cycle of infrastructure and facility components impacted by invasive species.

3.3.3 Water Quality

Description
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 salinity, temperature, oxygen, turbidity and nutrient levels in flow releases, and in-reservoir biological and geo-chemical (contaminants) processes.

2. Develop methods to predict, manage, and monitor effects of hydrologic variability on water quality (e.g. future hydrologic regimes, sea level fluctuations in estuarine environments).

3. Develop methods to monitor and control harmful algal blooms that impact water quality or delivery.

3.3.4 Sediment Management

Description
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. Improve monitoring methods to track sediment released from or augmented 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 guidelines for managing downstream sediment transport and deposition associated with reservoir sluicing.

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

6. 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 from fires as well.

3.3.5 River Habitat Restoration

Description
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, and riparian vegetation enhancement.

Coordination Contact
Jennifer Bountry

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

Needs Statements
1. Develop alternatives that eliminate need for fish screens.

2. Improve upstream and downstream fish passage at dams.

3. Develop ecosystem health indicators throughout watershed.

4. Evaluate post-construction habitat and design feature performance for rehabilitation projects.

5. Better understand effects of ecohydraulics on habitat availability, connectivity, and food webs for aquatic species.

6. Improve future channel change predictions in habitat rehabilitation areas and near Reclamation infrastructure.

3.4 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.

3.4.1 Water Supply and Streamflow Forecasting

Description
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. Investigate new technologies and methods to (1) enhance basin hydrologic condition monitoring and/or (2) characterize basin properties (e.g. remote sensing of snow water equivalent [SWE]).

2. Develop techniques to extend or improve skill of temperature and precipitation forecasts to the sub-seasonal time frame, with emphasis on wet/dry extreme events. This includes advancements to wining solutions from the Sub-Seasonal Climate Forecast Rodeo prize competitions.

3. Research machine learning and artificial intelligence methods toward use for a range of prediction tasks (e.g. weather, streamflow, etc.) and timescales (e.g. short-term, sub-seasonal, seasonal, etc.).

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

5. Explore possible hydrologic model performance enhancements by leveraging new or additional data for model calibration and forcings (e.g. Gridded Meteorological Ensemble Tool [GMET]).

3.4.2 Water Operations Models and Decisions Support Systems

Description
Develop and improve reservoir/river system operations and planning models and decision support systems in order to more optimally manage water delivery and use for Reclamation.

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 improve real-time, collaborative, multi-objective water management decision making/operations.

2. Develop approaches and tools to support and improve long term planning for changing or uncertain future hydrologic conditions.

3. Develop approaches to utilize new or improved data with existing models toward enhanced operational outcomes.

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

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

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

3.4.3 Open Data

Description
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 within Reclamation, and with other agencies, stakeholders, and the public. Proposing teams should pursue projects that complement Reclamation Information Sharing Environment (RISE) https://data.usbr.gov/.

Coordination Contact
Ken Nowak

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 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. Develop tools and resources that facilitate adoption and expand utilization of RISE. This may include development and deployment of new data management resources or enhancements to existing ones for compatibility with the RISE system.

3. Recognizing advances and trends in data search and usage (e.g. web 3.0, semantic web, etc.) that leverage enhanced metadata and learning algorithms, identify and evaluate such technologies for applicability and effectiveness in Reclamation information management; how can Reclamation prepare to take advantage in a timely manner?

3.4.4 Climate Change and Variability

Description
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 weather and climate data in water management applications.

2. Develop methods for communicating results and uncertainties to decision makers.

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

4. Explore and quantify uncertainty associated with future water availability projections developed from climate model output.

3.5 Developing Water Supplies (WS)

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

3.5.1 Advanced Water Treatment

Description
Develop technologies, methods, tools and approaches to advance the treatment of impaired water sources that allow Reclamation to better utilize existing supplies, increase existing Reclamation supplies through augmentation, or prolong existing Reclamation supplies by expanding or developing non-traditional supplies from an outside source such as impaired groundwater or surface water.

Coordination Contact
Yuliana Porras-Mendoza

Source of Research Needs
Desalination: A National Perspective and Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater

Needs Statements

1. Enhance water management decision making by quantifying the non-monetized costs and benefits of potable and non-potable water reuse compared with other water supply sources.

2. Reducing the environmental impact of water treatment by:
    a. Reducing chemical usage.

    b. Mitigating biofouling.

    c. Improving concentrate management.

3. Develop improved techniques and data to consider hazardous events or system failures in risk assessment of water reuse.

4. Develop innovative new water treatment systems (membranes, systems, processes, etc.) for treatment of impaired water for various uses (potable, industrial, storage, municipal, agricultural, etc.).

5. Develop models for implementation and management of various water sources in need of one or more treatment for one or more end use.

6. Develop innovative new materials, membranes, and/or systems and processes for treatment of impaired water.

7. Development of water-energy nexus research in the following areas:
    a. Coupling of renewable energy sources with water treatment processes.

b. Modeling of energy efficiency for innovative new water treatment processes or combination of existing water treatment processes.

c. Treatment and use of produced/fracking water for increase in water supply and energy production.

3.5.2 Groundwater Supplies

Description
Develop and improve solutions and tools that advance and optimize groundwater storage and conjunctive groundwater/surface water storage and use for Reclamation projects.

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

3.5.3 Agricultural and Municipal Water Supplies

Description
Develop and improve solutions and tools that automate, measure, and deliver agricultural water resulting in liberated water or a cost savings for Reclamation or its stakeholders. Research technologies that enhance water availability through weather modification or other novel approaches.

Coordination Contact
Yuliana Porras-Mendoza

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

Needs Statements
Research to understand winter orographic cloud seeding effectiveness and impacts.

3.5.4 System Water Losses

Description
Develop and improve solutions 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.