BUREAU OF RECLAMATION

2020 Desalination and Water Purification Program Project Descriptions

City of Westminster: Pilot project for advancing the application of integrated membrane systems (UF/RO) for reduction of trace organics and NDMA, beneficial reuse of the RO concentrate, and establishing guidelines

Reclamation Funding: $347,500 **Total Project Cost: $695,000**

For the past 15 years, the City of Westminster has been challenged with water increasing growth and associated shortages, impacting its ability to provide sustainable water supply to public amenities and private businesses. The city is now considering potable reuse by purifying the effluent of the existing wastewater treatment plant and augmenting the Cranberry Reservoir, which is the source of the current membrane filtration water treatment plant. This is the first potable reuse project in the State of Maryland.

Columbia University: Enabling enhanced water recovery and minimized concentrate for desalination of San Joaquin Valley Irrigation Drainage

Reclamation Funding: $249,995 **Total Project Cost: $249,995**

The irrigation drainage water in California's San Joaquin Valley is a prominent example, where recovery yields are severely constrained due to the atypically high-water hardness. This project aims to develop a framework for identifying the best technology pathway to optimize the cost-effectiveness of brackish water desalination using the San Luis plant in San Joaquin Valley. By concurrently addressing all the principal performance parameters of recovery yield, product water quality, and concentrate management cost, the study is expected to yield convergence outcomes that can serve other desalination facilities.

Epiphany Solar Water Systems, LLC: Transformational water desalination through innovative, low cost mechanical vapor recompression distillation

Reclamation Funding: $275,308 **Total Project Cost: $1,123,706**

Epiphany seeks to cost effectively recycle more oil and gas wastewater rather than continuing to put this wastewater into saltwater disposal wells. The project will focus on designing and optimizing the technology into a portable, trailer-integrated sized system to serve as a rapid and reliable treatment system to treat oil and gas produced water.

Lehigh University: Toward energy efficient municipal and brackish wastewater recovery: Potential of a new hybrid ion exchange-desalination (HIX-Desal) process

Reclamation Funding: $225,719 Total Project Cost: $253,799

Recent studies at Lehigh University have validated for the first time that a hybrid ion exchange desalination process, that does not require any membrane, is extremely energy efficient for treating a feed with salinity up to 1000 mg/L. This project will focus on testing wastewater from Allentown Wastewater Treatment Plant to validate the energy superiority of the process when compared to reverse osmosis.

New Mexico Institute of Mining and Technology: Hydrophilic-omniphobic hollow fiber membrane-based direct contact membrane distillation and crystallization for zero liquid discharge of oilfield produced water

Reclamation Funding: $249,991 Total Project Cost: $500,276

Direct contact membrane distillation is a promising technology to desalinate high-salinity oilfield produced water with theoretically 100% salt rejection. The purpose of this proposed project is to develop a novel hydrophilic-omniphobic hollow fiber membrane based direct contact membrane distillation and crystallization process for cost-effective and energy-efficient desalination of produced water.

New Mexico State University: Unit design of pretreatment process for per- and polyfluoroalkyl substances (PFAS) removal in desalination plants

Reclamation Funding: $249,386 Total Project Cost: $498,772

The goal of this study is to design and fabricate an energy-efficient and environmentally friendly bench-scale system for removal of per- and polyfluoroalkyl substances (PFAS) from water resources to improve pretreatment process. The PFAS removal system will be used as pretreatment for desalination to reduce fouling on membranes and address the current challenges in the disposal of PFAS-enriched concentrate generated from desalination.

Membrion, Inc: Nanoporous ceramic membranes for nitrate removal from groundwater

Reclamation Funding: $175,000 Total Project Cost: $350,000

This project proposes the development and testing of novel membranes composed of a functionalized nanoporous ceramic to selectively remove nitrates from groundwater. While nitrates can occur naturally in the environment at low levels, water supplies can become contaminated with nitrates from land use activities at levels high enough to pose a risk to public health.

Purdue University: Ultra-efficient solar-thermal batch reverse osmosis with novel thermal reverse osmosis engine

Reclamation Funding: $250,000 Total Project Cost: $513,898

This project is proposing to develop a novel solar groundwater desalination system that achieves high efficiency by directly converting high-temperature solar heat to pump power, which drives an efficient batch reverse osmosis unit. The applicant won Reclamation's 2017 "More Water, Less Concentrate Challenge" by demonstrating that batch reverse osmosis has the potential to reach high

efficiency, fouling resistant, lower costs, and reach higher concentrations than traditional reverse osmosis. This project will continue the development of this technology.

Sephton Water Technology, Inc: Barometric evaporator pilot project
Reclamation Funding: $75,100 **Total Project Cost: $316,135**

This proposed project will test a pilot scale Barometric Evaporator. This project follows testing and validation of this process at a bench scale under a previously funded DWPR research project in 2013. This project will expand on the prior testing at pilot scale by measuring capacity scale up potential, dramatically increasing recovery and reducing discharge, and extending the temperature range of operation, thus enabling an estimation of the economic competitiveness of the technology.

Silicon Valley Clean Water: Linking anaerobic wastewater treatment to non-potable and potable wastewater reuse
Reclamation Funding: $799,908 **Total Project Cost: $4,260,813**

Current water reuse treatment trains can reliably achieve potable reuse standards, but they still confront energy, footprint, and cost challenges that can be addressed by updating core municipal wastewater treatment processes. This project would focus on demonstrating at scale how a novel anaerobic biological treatment system could be integrated with reuse trains to achieve potable and non-potable reuse water more efficiently than existing processes.

Solar Multiple, LLC: Impingement evaporation of concentrated wastewater brine using solar heat
Reclamation Funding: $120,091 **Total Project Cost: $480,657**

The goal of this project is to demonstrate how the common practice of impingement drying can be applied to wastewater brine concentration economically. The proposed Impingement Evaporation System uses renewable energy and the intent is to optimize a design and pilot a prototype at Reclamation's Brackish Groundwater National Desalination Research Facility in Alamogordo, New Mexico.

Surplus Management, Inc: Impact-RO (Intelligent, micro-disrupting, parallel and cascade train reverse osmosis technology) – An energy efficient low-fouling high-recovery reverse osmosis system for brackish water desalination
Reclamation Funding: $272,775 **Total Project Cost: $545,575**

Watersurplus own patented Impact-RO system goal is to further reduce fouling of membrane based brackish water desalination systems and lower the energy usage. This project is focused on testing this system and development of the scaling characteristics on the membrane surface under real operating conditions using the brackish well waters available at Reclamation's Brackish Groundwater National Desalination Research Facility as the feedwater.

Texas A&M Engineering Experiment Station: Treatment of high salinity produced water to reduce freshwater utilization for oil and gas operations while creating a new source of higher quality water using a novel thermal desalination process

Reclamation Funding: $250,000 Total Project Cost: $500,000

The goal is to develop and optimize low cost, efficient, scalable, and easily implementable processes to reuse some of the 300 million gallons of produced water generated daily in the Permian Basin. This project will look at combining aluminum chemical and electrocoagulation with polymers to induce extremely high rate sedimentation of suspended solids to produce clean brine for reuse in hydraulic fracturing and desalinate clean brine via novel humidification-dehumidification process. This project will bring in partners from industry and international academic institutions.

Texas A&M University-Kingsville: A multi-level, multi-stage modeling framework for the analysis and design of seawater desalination using renewable energy

Reclamation Funding: $150,543 Total Project Cost: $207,892

The expected outcomes of this research project will include an expanded knowledge base of a technological field and an emerging industry as well as a modeling tool to improve the understanding and design of seawater desalination using renewable energy systems which may contribute to accelerated adoptions of technology. The seawater desalination plant currently under permitting phase in the City of Corpus Christi, TX will be used as a location to test the model.

Texas State University: Enhanced water recovery by a combination of photobiological process and secondary reverse osmosis – lifecycle cost analysis and mini-pilot study

Reclamation Funding: $250,000 Total Project Cost: $351,143

A new photobiological treatment method for RO concentrate has been developed to enable more water recovery using the secondary RO. This project proposes to demonstrate the continuous, long-term operation of diatom-based photobiological treatment of OR concentrate at full-scale and investigate the secondary RO desalination of photobiologically treated RO concentrate to determine proper pre-treatment requirements. The project will also include a lifecycle cost analysis to evaluate the economic feasibility of the proposed enhanced water recovery scheme.

University of Alabama: Functionalized magnetic metal organic framework thin-film nanocomposite membranes with real-time induced vibrations for enhanced antifouling

Reclamation Funding: $250,000 Total Project Cost: $500,000

The proposed work targets the fouling phenomena, as the main limiting factor of membrane technology, to provide an efficient, low cost, and environmentally friendly anti-fouling ability of the membranes. Project success would be to create membranes with new electromagnetic vibrational antifouling ability capable of showing two times higher anti-fouling properties than the current thin-film nanocomposite membranes active operation time.

University of Alabama: Enhanced PFAS removal through synergistic biofiltration and nanofiltration treatment: role of NOMPFAS characteristics

Reclamation Funding: $153,106 **Total Project Cost: $307,055**

Nanofiltration is a promising technology that has demonstrated success in removing emerging contaminants, such as per-and polyfluoroalkyl substances (PFAS), from source water but frequent fouling of the membrane by natural organic matter reduces the PFAS rejection and permeation. The goal of this project is to reduce nanofiltration membrane fouling for enhanced PFAS removal through a synergistic treatment process of biological filtration and nanofiltration.

University of California, Irvine: A real time sensor for pathogen detection in water reuse

Reclamation Funding: $250,000 **Total Project Cost: $443,750**

Due to the lack of a real-time monitor for pathogen removal, redundancies of treatment processes are required to protect humans from exposure to pathogens during water reuse. This project is to develop a real-time pathogen sensor for rapid monitoring of bacteria and virus removal efficiency during water reclamation.

University of Minnesota: Forced convection enhanced evaporation for brine management from inland brackish water desalination systems

Reclamation Funding: $250,000 **Total Project Cost: $500,000**

Concentrate management for inland desalination plants typically entails high upfront capital costs and/or high energy usage. The goal of this project is to experimentally validate a forced convection enhanced evaporation system aimed at reducing the capital and energy costs and increasing the climatic resilience of inland desalination concentrate management.

University of Missouri: Super hydrophobic laser induced graphene-ceramic composite membrane for membrane distillation

Reclamation Funding: $250,000 **Total Project Cost: $408,080**

The objective of this project is to fabricate a novel superhydrophobic graphene/alumina composite tubular ceramic membrane to be used in direct contact membrane distillation (DCMD). Membranes currently used in distillation are not specifically designed for membrane distillation and are affected by wetting, fouling, and low salt rejection. This new membrane could be a solution to these current issues.

University of Wisconsin - Milwaukee: Development of novel nanofiltration membranes based on multilayered covalent organic frameworks for desalination

Reclamation Funding: $246,919 **Total Project Cost: $386,491**

This project will focus on developing a novel high-flux, robust, and scalable nanofiltration (NF) membranes with high salt rejection, and to systematically study the membrane stability and fouling behaviors. The membrane materials are based on an emerging class of porous materials, covalent organic frameworks, which feature ordered and tunable pore size, tailored functionalities, and excellent stability.

Virginia Polytechnical Institute & State University: Ensuring the sustainability of indirect potable reuse and aquifer recharge

Reclamation Funding: $487,104 **Total Project Cost: $1,689,888**

The development of cost-effective advanced treatment processes that can reliably eliminate health risks and environmental impacts associated with wastewater effluent is essential for expanding potable reuse applications. This project seeks to improve the sustainability and broaden the applicability of non-membrane advanced water treatment approaches by intensification of these processes. In this context, intensification means achieving the same or better water quality with lower capital and operating costs while continuing to address prevalent technical challenges.