Desalination and Water Purification Research Program: 2022 Pitch to Pilot Projects

California

Carollo Engineers, Inc.: Pilot Testing of a Novel Energy Efficient Configuration for Carbon Diversion and CEC Removal

Reclamation Funding: $200,000 **Total Project Cost: $282,266**

Carollo Engineers has teamed with Eastern Municipal Water District, Cal Poly Pomona, DuPont, and Aquacycl to set up and operate a novel wastewater pilot treatment configuration to produce water suitable for recharging groundwater basins, while diverting organic carbon and consuming less electrical power than conventional approaches, and while providing a means to remove Chemicals of Emerging Concern (CECs) from the environment. A 20 to 30-gpm pilot system incorporating treatment of primary effluent with microfiltration, closed circuit reverse osmosis, and a microbial fuel cell operating on the reverse osmosis concentrate will be set up at an existing wastewater treatment plant. This study will help to further develop a more energy efficient approach to produce water for groundwater recharge and help to address the growing need to find solutions to remove CECs, including PFAS, from the environment. If successful, the novel treatment approach could be applied at wastewater treatment plants considering groundwater recharge in both coastal and inland communities.

Carollo Engineers, Inc.: An Innovative Ion Exchange-Based Advanced Treatment (XBAT) Approach for Direct and Indirect Potable Reuse

Reclamation Funding: $199,989 **Total Project Cost: $764,693**

For both direct potable reuse and indirect potable reuse applications, there are two prevailing treatment approaches: one centered on reverse osmosis (RO), known as RO-based advanced treatment (RBAT), and the other known as carbon-based advanced treatment (CBAT) and based on a combination of ozone-biologically active filtration and granular activated carbon adsorption. Yet, these status quo treatment technologies can only meet potable reuse water quality goals while generating large volumes of residual waste streams and consuming intensive amounts of energy. This project proposes the testing of XBAT, which consists of suspended ion exchange for dissolved organic matter and inorganic anion (e.g., nitrate, nitrite, phosphate, sulfate, bromide, chloride, etc.) removal, in-situ resin regeneration using bicarbonate, and softening for hardness and further total dissolved solids removal. Compared to RBAT, XBAT addresses chemical and potentially pathogenic contaminants without producing a large volume of RO concentrate. By coupling ion exchange and softening processes, XBAT provides multiple treatment barriers for both inorganic and organic contaminants and thus improving the overall treated water quality as compared to CBAT.

Orange County Water District: In-Situ Gravity Driven Removal of PFAS During Groundwater Recharge to Protect Drinking Water

Reclamation Funding: $199,430 **Total Project Cost: $406,423**

The purpose of this project is to determine the feasibility of removing per- and polyfluoroalkyl substances (PFAS) from impaired source waters in situ during managed aquifer recharge via deployment of a novel adsorbent media in native soils to improve efficiency of the soil aquifer treatment process. Pilot-scale column testing will be performed using Santa Ana River water which has low concentration PFAS. Performance of control columns (packed with native soils only) will be compared against treatment columns, which will be loaded with native soil and novel adsorbent media underneath. Field demonstration scale testing will evaluate the performance of the proposed technology in the field at demonstration scale up to 0.5 acres. This testing will assess the overall feasibility and effectiveness of the proposed technology for removing PFAS by quantitative comparison of the dual bed system to non-modified, native infiltration. The project outcomes will benefit the broader water community, particularly entities struggling with PFAS removal from water with elevated carbon content.

Colorado

South Platte Renew: Retrofitting Existing Infrastructure for Sidestream Biological Phosphorus Treatment to Reduce Coagulant Costs and Discharged Salts Associated with Chemical Phosphorus Removal

Reclamation Funding: $100,000 **Total Project Cost: $175,000**

Although chemical phosphorus removal (CPR) has been proven to be effective in meeting lower phosphorus targets, South Platte Renew (SPR) would like to implement sidestream enhanced biological phosphorus removal (EBPR) to optimize chemical costs, reduce the amount of additional aluminum, iron, chloride, and sulfate discharged to the South Platte River (resulting from CPR), and improve process resiliency and efficiency. SPR will utilize existing infrastructure to develop an internal carbon source for the phosphate accumulating organisms that will reside in a sidestream anaerobic reactor (SAR). SPR will first thicken its primary sludge and then send the thickened sludge to a gravity thickener (physically and mechanically modified DAFT to operate as a gravity thickener) to separate the thickened primary sludge from the liquid stream containing readily biodegradable chemical oxygen demand and volatile fatty acids. SPR will then supply the SAR (an existing reaeration basin retrofitted to operate as an anaerobic reactor) with return activated sludge and the internal carbon source. SPR anticipates that approximately 243 pounds per day of ortho-phosphorus will be removed by sending 0.53 million gallons per day of the internally sourced carbon to the SAR, lowering the operating costs and preventing increases in effluent total dissolved solids associated with CPR.

Michigan

Enspired Solutions LLC: Reductive Defluorination PFAS Destruction Field-scale Pilot Test

Reclamation Funding: $200,000 Total Project Cost: $404,202

Destruction of PFAS molecules by any method is an energy-intensive endeavor. Breaking the molecules into nontoxic components requires breaking a multitude of carbon-fluorine bonds, one of the strongest bonds in nature. As a result, energy use is an inhibitor and the predominant cost driver for commercializing PFAS destruction technologies. This project will test a field-scale pilot to evaluate the technical effectiveness and economic feasibility of combining foam fractionation, a PFAS concentration approach, with the patented PFAS destruction technology to destruct PFAS in industrial wastewater at a commercial chemical producer. The success criterion is to continuously treat the industrial wastewater at the required flow rate and decrease the PFAS compounds to concentrations that meet regulatory requirements in the plant discharge at an affordable price.

Nevada

Southern Nevada Water Authority: Assessment of Innovative Dissolved Air Flotation Approaches for Conventional Water Treatment

Reclamation Funding: $200,000 Total Project Cost: $412,500

Increased particle loadings are frequently challenging for drinking water treatment facilities, specifically direct filtration plants, and may result in decreased water production capacity and finished water quality. Conventional clarification processes are used to address higher particle loadings but require a significant footprint and capital cost for systems that may be used only on an intermittent basis. This project examines the integration of dissolved air flotation (DAF) into the existing footprint of the treatment plant, between flocculation basins and filter influent, to remove these particles. DAF introduces air bubbles to attach to particles and particle-bubble aggregates float to the surface where they are mechanically removed. If an innovative DAF solution can be incorporated into the existing treatment process, it could be operated on an as-needed basis to reduce particle loadings to the filters and maintain water production rates, while significantly reducing footprint and capital cost requirements of a new conventional clarification system. Additionally, integration of DAF into the filter backwashing procedure will be examined to minimize backwash volumes and produce water savings. Learnings disseminated through the final report, presentations, and peer-reviewed publication, can be used to inform other direct filtration plants that are considering treatment options for elevated particle loadings.

New York

Hazen and Sawyer: Pilot Scale PFAS Destruction in Membrane Concentrate via Electrochemical Oxidation

Reclamation Funding: $196,916 Total Project Cost: $246,916

The destruction of per- and polyfluoroalkyl substances (PFAS) remains a critical hurdle in the remediation of PFAS contaminated sites. While previous bench-scale studies have established the effectiveness of electrochemical oxidation (EO) as a promising PFAS destruction technology, the bulk of these studies extrapolate destruction performance using synthetic PFAS-contaminated matrices. In this proposed two-phase pilot study, an EO pilot skid will be operated in the treatment of PFAS impaired membrane concentrate from the Brackish Groundwater National Desalination Research Facility in Alamogordo, NM. This pilot demonstration seeks to better understand the long term PFAS destruction performance of EO to supplement the residuals handling associated with existing PFAS membrane separation processes. Outcomes of this project may reduce the long-term environmental impact of PFAS impaired membrane concentrate disposal with lower energy requirements and cost than other destruction approaches.

The Research Foundation for The State University of New York (Stony Brook University): Enhancing the Removal of Hydrophilic Per- and Polyfluoroalkyl Substances (PFASs) by Granular Activated Carbon using Hydrophobic Ion-pairing as Pre-treatment

Reclamation Funding: $199,601 Total Project Cost: $225,960

Granular activated carbon (GAC) is a cost-effective adsorbent widely applied for drinking water treatment that is effective in the removal of hydrophobic long-chain PFASs, but not as effective for the removal of hydrophilic short-chain PFASs. This project proposes a simple cost-effective pretreatment to GAC treatment to enhance the removal of both short-chain and long-chain PFASs and increase the lifetime of carbon. The use of "hydrophobic ion-pairing" is proposed as a pretreatment to enhance the removal of both short-chain and long-chain PFASs without the need for any modification of GAC material. Hydrophobic ion pairing (HIP) is a concept by which an ion pair complex is made through the interaction of a hydrophilic ion of interest with a hydrophobic counter-ion, making the overall molecule hydrophobic. In the case of PFAS, a cationic HIP agent will be added to the influent of GAC systems, resulting in the formation of PFAS-HIP ion pairs with higher hydrophobicity and thus are removed efficiently by GAC filters. The overall goal of this proposed project is to demonstrate this approach in a pilot scale GAC system to treat contaminated groundwater.

North Carolina

Hazen and Sawyer: Improving RO Recovery through Optimization of Flux and Pump Usage with Real-Time Sensor Connectivity, Data-driven Modeling, and Automation

Reclamation Funding: $197,294 **Total Project Cost: $362,294**

Reverse Osmosis (RO) operation is an energy-intensive process, and the cost of RO treatment can be a barrier to its widespread adoption. In most brackish and seawater desalination and water reuse applications, RO membrane recovery (and production) is limited by scaling chemistry. The RO membrane trains are typically operated in a steady state flow condition optimized for a water recovery setpoint with no ability for real-time adjustment of flow, pressure, and membrane flux to accommodate changing water quality and membrane performance conditions. Design and operating parameters are based on conservative design conditions to maximize water recovery while meeting product quality objectives and avoiding scaling or fouling. Further limiting the ability to build automation into process controls, many RO facilities lack the ability to integrate sensor data from disparate sources and evaluate the data quality in real time. Given the conservative approach and manual data analytics and normalization there are opportunities to operate at more efficient settings. Thus, the goal of this project is to use connected sensors and real-time data acquisition coupled with machine learning and the latest in process automation to develop predictive algorithms with automated advisory process controls that can optimize pump energy, membrane flux (i.e., production), RO recovery and RO feed acid dosing/ antiscalant dosing to reduce energy, maximize production, and minimize chemical costs while maintaining membrane condition by minimizing fouling and scaling.