



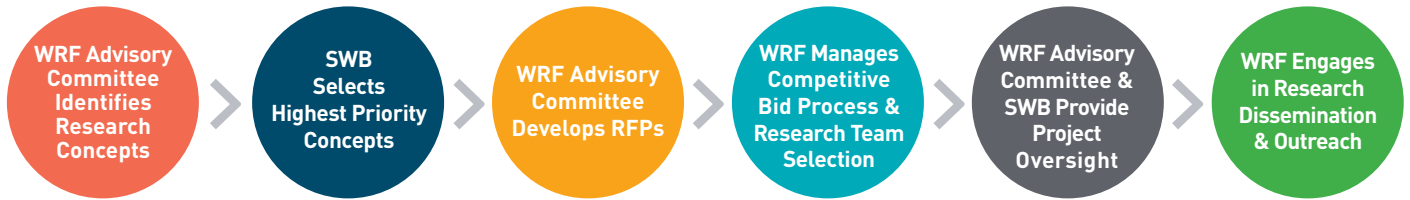
# WATER REUSE RESEARCH COLLABORATIVELY FUNDED RESULTS



Through a pair of research grants provided by the **California State Water Resources Control Board (SWB)**, The Water Research Foundation (WRF) has worked to deliver a robust body of water reuse science. Grant 2 research, which focuses on critical potable and non-potable reuse issues, will be completed in 2024. Initially funded at \$3.1M, the research was leveraged by WRF and other key partners into a research portfolio with a total value of more than \$8.8M.

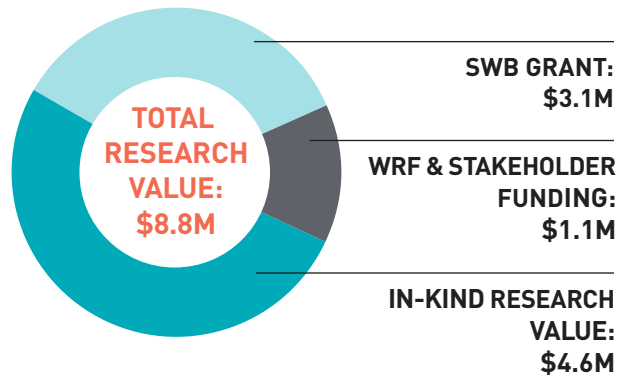
## THE PATH TO CRITICAL RESEARCH

Over a seven-year period, WRF worked closely with SWB in a comprehensive effort to deliver high-priority reuse research to the water sector. This collaboration tapped into WRF's Research Priority Program process, using WRF resources and management expertise, including oversight from WRF's Water Reuse Advisory Committee. Once the research was complete, the partnership continued to provide value, providing the guidance and tools needed in the field, as well as research dissemination and outreach.



## LEVERAGING FUNDING

During the course of the research effort, SWB's initial grant of \$3.1M was leveraged into a body of science valued at nearly three times that amount. Once the project concepts were developed, WRF, the Metropolitan Water District of Southern California, and other stakeholders, including utilities across the United States, engineering firms, and manufacturing companies, raised an additional \$1.1M to address the need. In-kind research brought the total value of this research to more than \$8.8M.



## CALIFORNIA STATE WATER RESOURCES CONTROL BOARD GRANT RESEARCH: GRANT 2

PROJECT TITLE & NUMBER	FUNDING AMOUNT	TOTAL INVESTMENT	OVERVIEW
Evaluation of CEC Removal by Ozone/BAF Treatment in Potable Reuse Applications (4832)	\$300,000	\$822,740	Identifies CECs not reliably removed by ozone/BAF, benchmarks expected water quality from ozone/BAF-based treatment trains, and provides design and operational guidance and outreach tools to assist in implementing safe and sustainable ozone/BAF-based treatment in potable reuse applications.
Understanding the Impacts of Wastewater Treatment Performance on Advanced Water Treatment Processes & Finished Water Quality (4833)	\$300,000	\$852,419	Examines whole-system performance and economics of wastewater treatment and the impacts on advanced water treatment. Provides practical tools to help utilities choose the best path for implementing potable reuse.
Considerations & Blending Strategies for Drinking Water System Integration with Alternative Water Supplies (4953)	\$400,000	\$643,521	Identifies and evaluates impacts of alternative water supplies, such as potable reuse, on the quality of water from existing drinking water systems. Helps better understand impacts of blending ratios and options to mitigate adverse impacts.
Integration of High-Frequency Performance Data for Microbial & Chemical Compound Control in Potable Reuse Treatment Systems (4954)	\$400,000	\$739,957	Provides a blueprint for utilities to implement monitoring and control systems that allow for enhanced integration and visualization of performance data, rapid automation of control process, and improved regulatory transparency.
Indicator Viruses for Advanced Physical Treatment Process Performance Confirmation (4955)	\$300,000	\$801,230	Identifies and evaluates potential viral indicators for assessing the performance of physical treatment processes during advanced water treatment for potable reuse.
State-of-the-Science Review: Evidence for Pathogen Removal in Managed Aquifer Recharge Systems (4957)	\$100,000	\$255,950	Documents the state of knowledge of pathogen reduction through managed aquifer recharge processes and assesses the benefits, limitations, and challenges of regulatory approaches for microbial disease protection.
New Techniques, Tools, & Validation Protocols for Achieving Log Removal Credit across NF & RO Membranes (4958)	\$350,000	\$877,723	Identifies direct integrity test (DIT) methods and performs long-term validation testing to demonstrate <i>Giardia</i> , <i>Cryptosporidium</i> , and enteric virus LRV credit for high-pressure RO and NF membrane systems.
Evaluation of Tier 3 Validation Protocol for Membrane Bioreactors Based on a Correlated Surrogate to Achieve Pathogen Credit for Potable Reuse (4959)	\$25,000	\$49,628	Evaluates the Australian WaterVal three-tiered MBR validation protocol to obtain LRV credits and identifies modifications needed to adapt it for use in the United States. Provides implementation recommendations for a tier-3 style regulatory approach for increased operational flexibility.
An Enhanced Source Control Framework for Industrial Contaminants in Potable Reuse (4960)	\$200,000	\$341,000	Identifies contaminants related to industry and manufacturing, the types of industries that may discharge these compounds, potential impacts to water quality and advanced treatment effectiveness, and mitigation strategies.
The Use of Next Generation Sequencing (NGS) Technologies & Metagenomics Approaches to Evaluate Water & Wastewater Quality Monitoring & Treatment Technologies (4961)	\$300,000	\$490,015	Documents the state of the science on NGS technologies, identifies key knowledge gaps and barriers to their implementation, validates relevant approaches, and provides guidance to aid in navigating options for NGS applications.

## CALIFORNIA STATE WATER RESOURCES CONTROL BOARD GRANT RESEARCH: GRANT 2

PROJECT TITLE & NUMBER	FUNDING AMOUNT	TOTAL INVESTMENT	OVERVIEW
Identifying the Amount of Wastewater That Is Available & Feasible to Recycle in California (4962)	\$105,000	\$171,355	Identifies current and projected amounts of treated municipal wastewater available for recycled water production in California. Provides high-level view of opportunities and limitations, highlighting factors that affect the feasibility of achieving recycled water goals.
Developing a New Foundational Understanding of SAR-Soil Structure Interactions to Provide Management Options for Recycled Water Use in Agriculture (4963)	\$200,000	\$380,000	Expands the understanding of salts in recycled water used for irrigation and the impact on soil condition and the yield and quality of salt-sensitive crops. Assists users of recycled water in fine tuning their irrigation practices and choice of chemicals.
Assessing the State of Knowledge & Impacts of Recycled Water Irrigation on Agricultural Crops (4964)	\$120,000	\$152,500	Assesses understanding and impacts of recycled water irrigation on agricultural crops, including how salinity, sodium, and chloride affect growth and production. Provides guidelines for sustainable water reuse with different crops/cropping systems along with communication and outreach pieces.
Potential of Oilfield Produced Water for Irrigation in California (4993)	\$150,000	\$196,603	Provides recommendations and decision tools for the reuse of oilfield-produced water for irrigation, including a framework and interactive online map to guide further expansion of the practice.
Pathogen Removal Credits for Wastewater Reuse: Guidance for Study Plans & Reporting (5047)	\$100,000	\$132,417	Provides guidance for crediting water resource recovery facilities with pathogen log reduction values.
Integrating Real-Time Collection System Monitoring Approaches into Enhanced Source Control Programs for Potable Reuse (5048)	\$200,000	\$356,343	Defines the level of real-time collection system monitoring that is feasible, appropriate, and necessary for protection of downstream potable reuse. Provides framework for integrating real-time monitoring into existing pretreatment program requirements.
Public Health Benefits & Challenges for Blending of Advanced Treated Water with Raw Water Upstream of a Surface Water Treatment Plant in DPR (5049)	\$125,000	\$618,813	Outlines the benefits and operational challenges of blending advanced treated water with raw or filtered water at SWTPs, provides strategies for optimizing SWTP unit processes to address challenges as well as approaches for validating pathogen log reduction credits under a DPR regulatory framework.
UV/Chlorine AOP in Potable Reuse: Assessment of Applicability, Operational Issues, & Potential Byproducts (5050)	\$150,000	\$304,784	Consolidates information on the state of UV/Cl-AOP into a single reference applicable to utilities, non-expert consultants, and regulators, including the basic science of UV/Cl-AOP and practical issues related to implementation and operation.
Geochemical Considerations for Managed Aquifer Recharge (MAR) Implementation in Potable Reuse (5051)	\$112,000	\$230,606	Advances the understanding and practice of MAR in potable reuse applications by identifying common challenges, best practices, and strategies to address the challenges. Provides decision support tool to guide utilities in assessing physical and geochemical issues during all phases of MAR projects.
Standardizing Methods with QA/QC Standards for Investigating the Occurrence & Removal of ARB/ARGs in Surface Water, Wastewater, and Recycled Water (5052)	\$200,000	\$286,197	Identifies, develops, and validates standardized methods for monitoring ARBs and ARGs in wastewater, recycled water, and surface water. Provides framework that aligns specific targets and methods with specific monitoring objectives.

## RESEARCH DISSEMINATION & OUTREACH

WRF's involvement in the SWB Grant 2 projects has continued well beyond the research phase. WRF's experienced team continues to advance the science, engaging in a concerted research dissemination and outreach effort. WRF plays a critical role in bringing the research to the field by producing tools, hosting workshops, presenting at conferences, hosting webcasts, publishing reports and guidance, and engaging in social media and digital outreach. This ensures that the research will be a sustainable resource for water reuse in California and around the globe.

**Look for these resulting tools and resources at [www.waterrf.org](http://www.waterrf.org):**

- Water Antibiotic Resistance Database (WARD)
- Geochemical Considerations for Managed Aquifer Recharge Implementation in Potable Reuse: Decision Support Tool
- LRV Credit Validation Study Cost Estimator and User Manual
- Geospatial Model and Map of Potential for Oilfield Produced Water Reuse
- Web Tool: Industrial Contaminant Review and Survey Results
- Next Generation Sequencing Technologies: Fact Sheet
- Frequently Asked Questions Related to CEC Removal by Ozone/BAC Treatment in Potable Reuse Applications

more than  
**100**  
publications  
& presentations



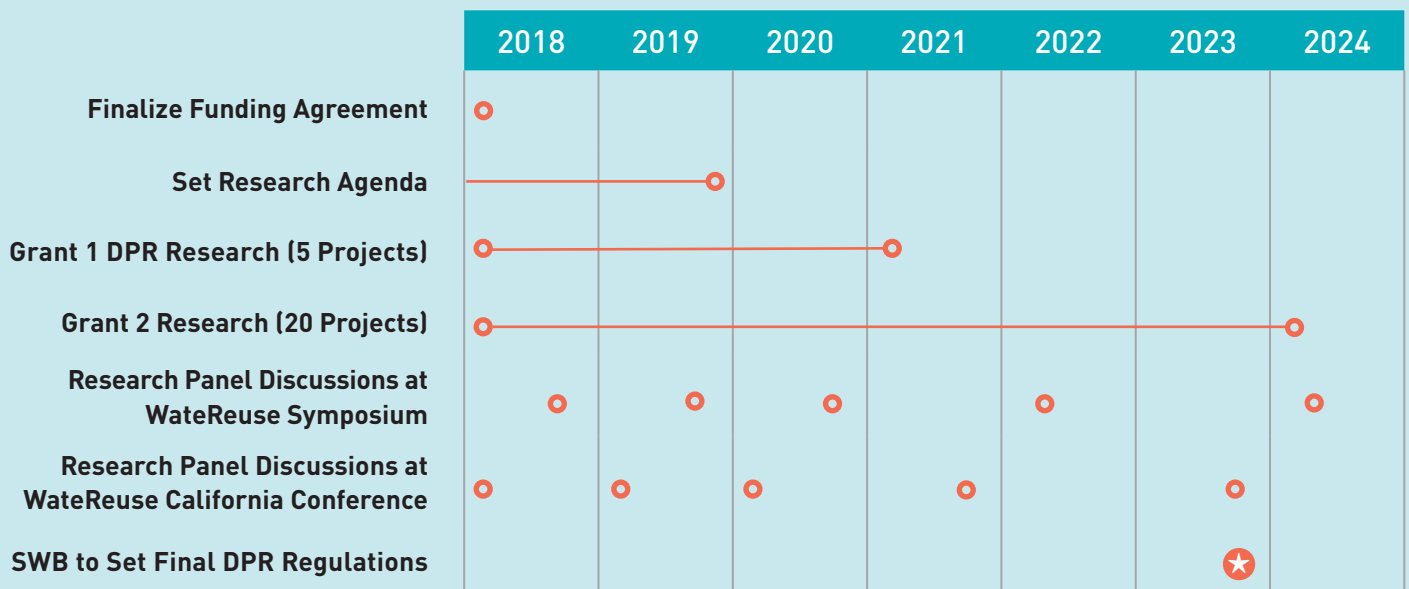
**7**  
live webcasts  
(now available on demand)



**5**  
web tools



## RESEARCH TIMELINE & MILESTONES



## MORE INFORMATION

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