



California Direct Potable Reuse Initiative

REPORTING ON SIGNIFICANT PROGRESS

Fall 2014/Winter 2015



Background

The Foundation, in partnership with WaterReuse California, launched the Direct Potable Reuse (DPR) Initiative in June of 2012 to advance DPR as a water supply option in California. This was driven by the establishment of statewide goals for the use of recycled water, and a mandate from the California legislature to come up with a feasibility of DPR criteria study by 2016 to investigate developing uniform water recycling criteria for DPR.

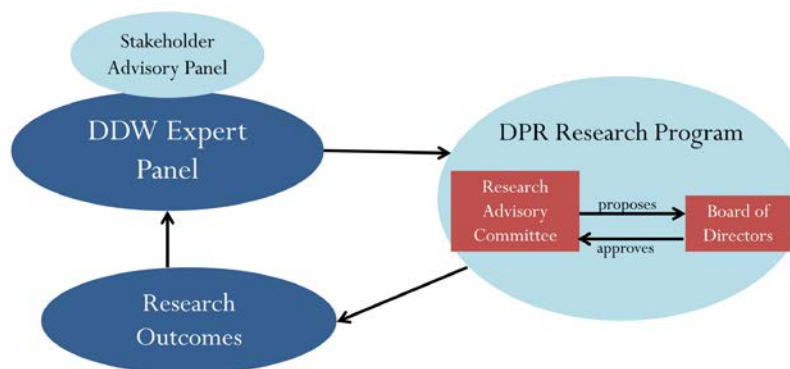
This Initiative was built upon a solid research program that started in 2011 when WRRF began funding research identified in WaterReuse's *Direct Potable Reuse: A Path Forward* publication. That insightful effort informed a DPR Research Needs meeting held in December 2012 which forged the framework of the Foundation's research agenda.

Since 2012, the DPR Initiative has raised over \$6 million for cutting edge DPR research. This includes \$500,000 in matching funds from the Metropolitan Water District of Southern California (MWD) and a partnership with Water Research Foundation for \$600,000. Not included in that total is a \$2.1 million grant from the Department of Water Resources and San Diego County Water Authority for a DPR demonstration project in San Diego launched in September, 2014.

Continued Success

To date, the Foundation has allocated \$4.5 million to fund [26 DPR research projects](#). This important research to address the regulatory, utility, and community concerns is valued at over \$11.5 million.

The California State Water Resources Control Board (SWRCB) has set up an [Expert Panel](#) under its new Division of Drinking Water Programs (DDW) to make a recommendation about the feasibility of developing DPR criteria by 2016. All of the research under our DPR Initiative is made available to the DDW Expert Panel for their consideration as they navigate the important task of determining the feasibility of DPR criteria by 2016.



So far in 2014, there has been significant progress in providing the Expert Panel with vitally needed information. Through two meetings (March 5 and July 24) and a NWRI report ([Vol I](#) and [Vol II](#)), WRRF has presented its [DPR Research Plan](#) and has received valuable guidance on additional research needed to ensure the safe and reliable use of DPR.

In response to the research areas identified by the Expert Panel, the WRRF Research Advisory Committee (RAC) convened on September 6 in Dallas, TX to develop additional DPR

research projects for funding. The RAC recommended a slate of seven new DPR projects valued at more than \$1 million, which were unanimously approved by the Board of Directors on October 2. The Board also approved four DPR projects for funding earlier this year, which means that the Foundation has funded 11 new DPR research studies in 2014 alone. The Foundation will continue to respond to the research needs of the Expert Panel, including at their upcoming third panel meeting on December 11-12 in San Diego.

Below is a table of research needs/themes identified by the DDW Expert Panel, and how the Foundation research is helping to address these important topics.

Project #	DPR vs. alternatives, Economics	Evaluation of potential DPR trains	Demonstration of reliable, redundant treatment performance	Critical Control Points	Pathogens: surrogates, credits	Pathogens: Rapid/continuous monitoring	Failure and resiliency	Public perception and acceptance	CEC removal and risk	Operations Training, Framework	Source Control
WRRF-11-01		x	x		x	x					
WRRF-11-02		x	x		x				x		
WRRF-11-05			x								
WRRF-11-10		x	x				x				
WRRF-12-06		x	x		x	x		x			
WRRF-12-07			x								
WRRF-13-02								x			
WRRF-13-03		x	x	x	x		x				
WRRF-13-12											x
WRRF-13-13							x			x	
WRF4508*			x								
WRF4536*					x						
WRRF-14-01			x		x	x					
WRRF-14-02					x						
WRRF-14-03	x	x									
WRRF-14-08	x										
WRRF-14-10		x	x	x	x	x					
WRRF-14-12	x	x	x	x	x		x		x		
WRA-14-01										x	
WRRF-14-13		x	x		x		x				

WRRF-14-14									x		
WRRF-14-15									x		
WRRF-14-16		x	x	x	x	x	x			x	
WRRF-14-17			x		x	x					
WRRF-14-18					x	x					
WRRF-14-19			x						x		

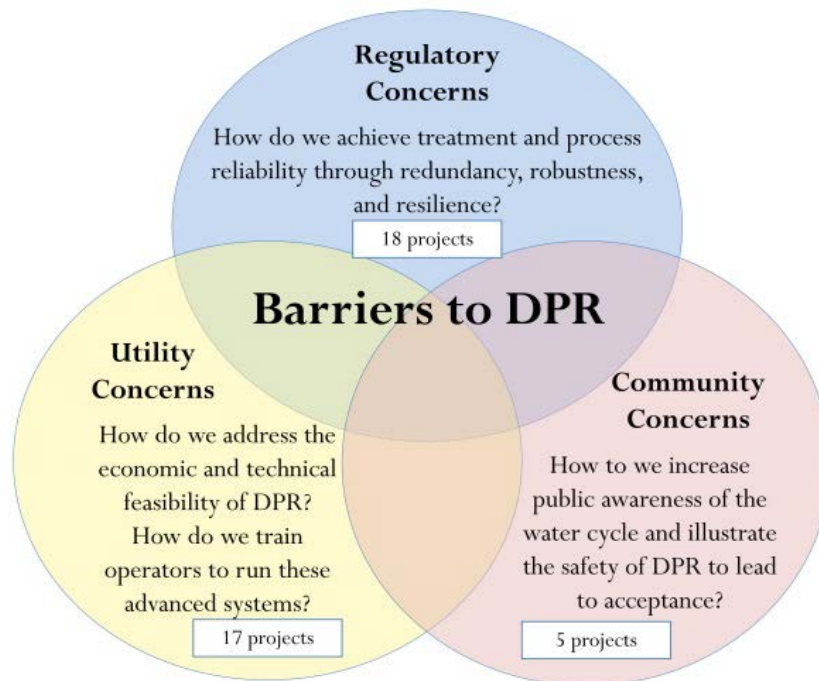
*funded and managed by Water Research Foundation

Since the last update in May, there have been several noteworthy events, some included in more detail in the project status summary:

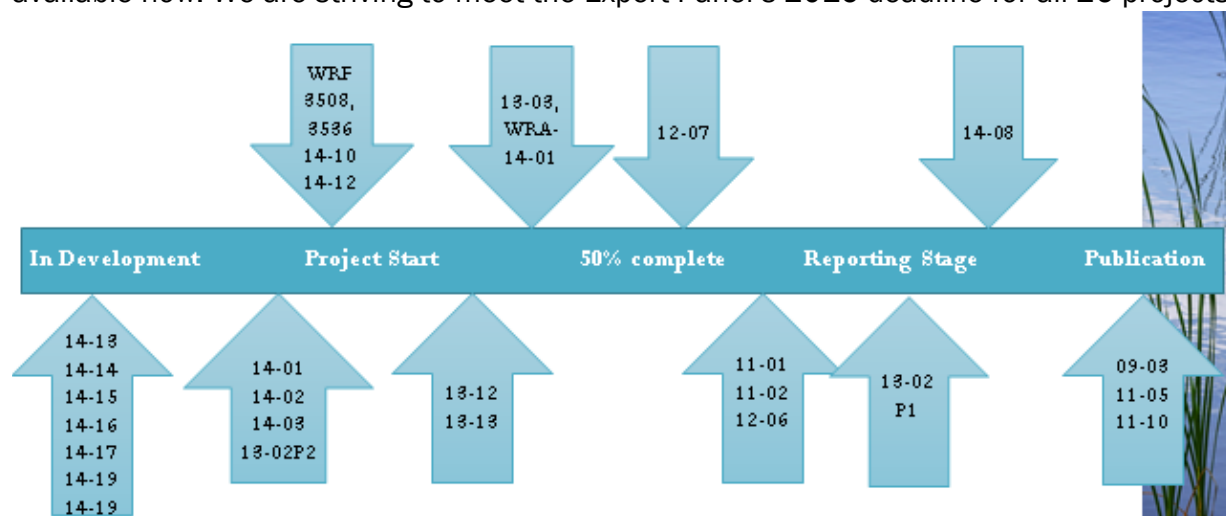
- State Water Resources Control Board Research Needs Workshop on October 29.** SWRCB assembled this meeting as an opportunity for Water Board executive managers and research organizations to convene with decision makers from CA drinking water, wastewater, and storm water agencies to identify research gaps that should be addressed to ensure recycled water is a safe water supply for people and the environment (there was an emphasis on DPR). SCCWRP, NWRI, and WRRF provided white papers in advance and presented the state of the science on 4 topics. Attendees discussed research needs in breakout groups in the afternoon. There will be a report available on the State Board website in December. New research needs will be presented to the WRRF RAC for new projects development and funding consideration.
- RAC Meeting and approval of 7 new projects.** The RAC convened on September 6 and recommended the funding of 7 additional DPR projects based on the recommendations of the DDW expert panel. See projects WRRF-14-13 through 19 below.
- Economics Report due for release in November.** The Foundation is in the process of finalizing WRRF 14-08, by Bob Raucher and George Tchobanoglous on the economics of DPR in California, which will estimate the potential cost savings from choosing DPR over alternatives and the total volume of “new water” that could be generated from DPR in California.
- New Public Engagement Video released.** The Foundation released the [Ways of Water](#), a brief video (in English and Spanish) that presents an overview of the many human interventions in the water cycle and looks at the benefits of some key water provision options including DPR. The animation is an easy-to-understand presentation of the urban water cycle and water purification. It is one component of a research project lead by Carollo Engineers titled *Guidelines for Engineered Storage for Direct Potable Reuse* (WRRF-12-06). The video was directed by James Hutson of Bridge8, and produced by New Water Resources.
- New seminal project initiated.** In September 2014, Trussell Technologies initiated their DPR demonstration project in San Diego, project WRRF-14-12 entitled *Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse*.
- DPR Communication Outreach Plans completed.** WRRF-13-02 Phase I has been completed, and model statewide and community plans will be available in late 2014.

WRRF Research

WRRF has funded 26 DPR projects addressing regulatory (18), utility (17), and community (5) concerns.



Most of the work is in progress; however several reports have been published and are available now. We are striving to meet the Expert Panel's 2016 deadline for all 26 projects.



Project Status Summaries

Prior to the DPR Initiative's start, the Foundation funded 6 projects valued at \$4M, 4 of which are ongoing.

Project #	Research Project Title	Principal Investigator	Expected Publication
WRRF-11-01	Monitoring for Reliability and Process Control of Potable Reuse Applications	Ian Pepper, University of Arizona	Nov-2015
WRRF-11-02	Equivalency of Advanced Treatment Trains for Potable Reuse (early reports: Examining the Criteria for DPR ; Potable Reuse: State of the Science Report)	Rhodes Trussell, Trussell Technologies	Sep-2015
WRRF-11-05	Demonstrating the Benefits of Engineered DPR versus Unintentional Indirect Potable Reuse Systems	Glen Boyd, The Cadmus Group Inc	published May-2014
WRRF-11-10	Risk Reduction Principles for DPR	Andy Salveson, Carollo	published Jul-2014
WRRF-12-06	Guidelines for Engineered Storage for Direct Potable Reuse	Andy Salveson, Carollo	May-2015
WRRF-12-07	Methods for Integrity Testing of NF and RO Membranes	Joe Jacangelo, MWH	Dec-2016

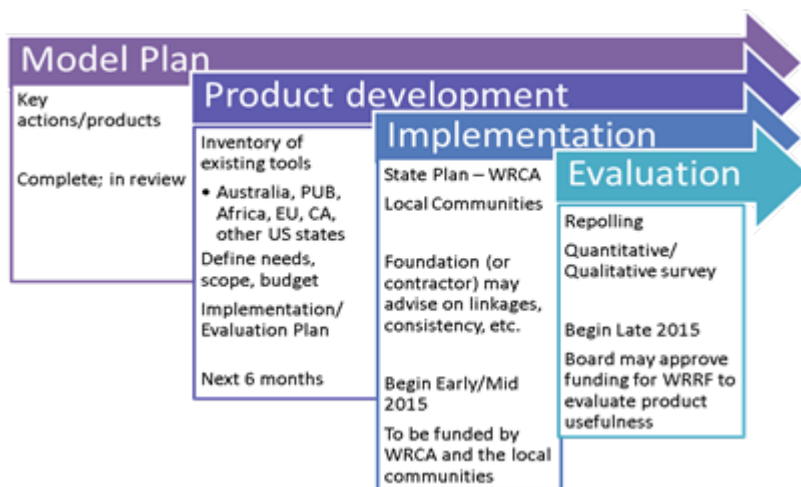
Projects Initiated in 2013 – funded by DPR Initiative and Metropolitan Water District

WRRF-13-02: Model Public Communication Plan for Advancing DPR Acceptance

The Foundation and WRCA are taking a three-phased approach to gain public acceptance of DPR in California:

1. Develop Strategic Communication Plans (state and local)
2. Develop Messaging Material and Methods
3. Implement, Evaluate and Refine Plan

As part of Phase I, focus groups and surveys were conducted mid-2014 to develop key messages critical to educational, awareness and outreach efforts. This phase has been accomplished, and the local and statewide communication plans will be available in late 2014.



To kick off Phase II, the Foundation is holding a workshop in November to develop and refine outreach tools and informational collateral materials as outlined in the Plans. These products will be available for utilities and other groups for use with their constituents, to educate and inform, and to expand their outreach and awareness programs.

WRRF-13-03: Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme

The **Hazen & Sawyer** project team (led by Troy Walker and Ben Stanford) is well underway:

Duration: December 2013 – April 2016

- To date, the project has followed in the sequence of the HACCP process with a HACCP team convened and critical control points identified in a workshop for both the full advanced treatment (MF-RO-AOP-Cl₂-Engineered Storage) and (Ozone/BAC-GAC-UV-Cl₂-Engineered Storage) treatment trains.
- A water quality risk assessment, normally conducted ahead of a HACCP workshop to outline the hazards that need to be mitigated, has been developed using knowledge and data from existing facilities along with a substantial literature review in support. It is being finalized at the time of writing.
- Water quality data from utilities has been delivered from four of the participating utilities with Monte Carlo analysis being conducted currently. Planning for full scale testing at the Scottsdale Water Campus began in July.

Objectives:

1. Conduct hazard assessment for key unit operations for two or more direct potable reuse (DPR) treatment trains, including the following:
 - a. MF/UF – RO – UV/H₂O₂ – Cl₂ – Engineered Storage
 - b. O₃ – BAC – GAC – UV – Cl₂ – Engineered Storage
2. Develop best design, monitoring, and operational practices by evaluating critical process control points in each of the DPR treatment trains evaluated to meet overall system robustness and reliability.
3. Develop standard design approaches and response strategies (i.e., operations plan and standard operating procedures) to mitigate upset events to strive towards 'fail-safe' operation of a DPR plant.

WRRF-13-12: Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR

The goals are to evaluate upstream wastewater treatment impacts (e.g. N/dN-nitrification/denitrification, industrial source control) on DPR source water quality and DPR process, and to evaluate impact of hydraulic control mechanisms (e.g. flow equalization and source water storage buffers) on influent water quality and flow variations that "stress" the DPR process.

Duration: July 2014 – June 2016

This project kicked off in July, and the **Black & Veatch** project team (PIs Alan Rimer and Sunny Wang) is currently focused on collecting utility information. They have sent a questionnaire to six utility partners that are recognized leaders in wastewater treatment and advanced water purification. Their goal is to review and summarize existing Source Control or Industrial

Pretreatment Program information and evaluate the impact of the WWTP's level of treatment has on performance and reliability at the AWPf. Each utility partner has different

wastewater treatment processes that represent a wide range of source water qualities treated by respective AWWPs. The team will host a kickoff call with the PAC once the utility responses are received.

WRRF-13-13: Development of Operation and Maintenance Plan and Training and Certification Framework for DPR Systems

Duration: May 2014 – April 2016

The contractor-led portion of the project officially commenced on May 5, 2014. The **Hazen and Sawyer** project team is led by Troy Walker and Ben Stanford. The project started with providing detailed reviews of both the local Californian code of regulations and certification & training requirements, respectively. This has provided a useful set of gap analyses prior to engagement directly with utilities to develop case studies on managing within the existing regulatory framework. In the next period, the project team will be working extensively on utility engagement for the next steps including the aforementioned case studies, review of operating protocols and systems, as well as staffing and management of certification.

The object of this project is to develop a standard operations and maintenance plan for various DPR treatment processes, including appropriate portions of the upstream secondary wastewater treatment processes providing feedwater to the DPR processes. A DPR Training and Certification framework for DPR system operators will also be developed.

WRF 4508: Assessment of techniques for evaluating and demonstrating safety of DPR product water &

WRF 4536: Blending Requirements for Water from DPR Treatment Facilities

Duration: October 2014 – October 2016

Both of these projects are funded and managed by the Water Research Foundation. The agreements were just signed in October, 2014. A joint kickoff project workshop is now being scheduled for January 2015.

4508: University of Arizona (Channah Rock)

The objectives of this project are to evaluate known techniques/methodologies (and potentially develop new technologies) for the assessment of DPR water safety (work with public outreach group to identify key criteria by which public would evaluate safety); to evaluate the effectiveness of currently accepted and alternative treatment trains for the production of DPR water using the developed techniques; and to develop tools and methods for utilities to demonstrate water safety to the public, elected officials, etc.

4536: Carollo Engineers (Andrew Salveson)

The objective of this project is to optimize with respect to water quality, the blending of DPR water with existing water supplies based on existing information. Phase II will conduct case studies of selected blending strategies.

Projects Initiated in 2014 – funded by DPR Initiative

There have been two rounds of **2014 DPR projects** approved by the Board this year. There have been three RFPs released (WRRF-14-01, 02, 03), four Tailored Collaboration or contracted projects underway (WRRF-14-08, 10, 12, WRA-14-01), and 7 newly approved projects with RFPs are in development. The Foundation welcomes participation on these [7 new projects](#) (pg 11) through utility support or peer review. RFPs can be expected in early 2015. Please contact [Julie Minton](#) or the project manager if you would like to serve on the PAC or if your utility would like to participate on the project (e.g. provide in-kind support).

WRRF-14-01: Integrated Management of Sensor Data for Real Time Decision Making and Response

Proposals for this project were received on October 9th. An award is expected to be made in November.

The objectives of this project are to develop an operations support tool that integrates sensors within the treatment process for immediate feedback/alerts. Existing sensors will be integrated into an early warning system for a Direct Potable Reuse (DPR) treatment process. This will provide a real time sensor network for tracking system performance and key quality parameters using a tool for early detection of system anomalies prior to any compromise in water quality.

WRRF-14-02: Establishing additional log reduction credits for WWTPs

The objectives are as follows:

- Obtain more accurate picture of the microbial treatment requirements by addressing the major source of uncertainty—the concentration of pathogens in raw wastewater and secondary effluent.
- Establish if there is any correlation between the number of pathogens in raw wastewater and secondary effluent.
- Establish removal credit for biological treatment provided (e.g., activated sludge) for protozoa, bacteria, and viruses.
- Determine validity of pathogen log-removal requirements identified by CDPH for potable reuse projects.

The RFP for this project was released on September 19th, and proposals are due on November 5th.

WRRF-14-03: Develop Methodology of comprehensive (fiscal/triple bottom line) analysis of alternative water supply projects compared to DPR

The objective of this project is to develop and demonstrate an assessment method (spreadsheet, database, or other) to provide information to decision makers in considering the full economic, social, and environmental impacts of a DPR water supply versus other alternative supplies.

Proposals for this project were received on September 26th. An award is expected to be made in November.

WRRF-14-08: The Opportunities and Economics of Direct Potable Reuse

The objective of this project is to determine how much DPR will cost in comparison to other sources of water. In addition, this project also looks at the amount of water in California that is potentially available for potable reuse.

Duration: April 2014 – November 2014

This project began in April and was conducted by **Bob Raucher of Stratus Consulting and George Tchobanoglous**. The result of this project will be a White Paper in which DPR will be described and compared – in terms of

cost, technical feasibility, reliability, energy requirements, carbon footprint, and potential yields – to other water supply alternatives. Case study information also will be provided, to indicate typical “complete advanced treatment” process flow diagrams and indicate costs and site-specific factors in field applications at the municipal utility scale. The development of the White Paper is currently in its final stages and is expected to be completed and published in November.

WRA-14-01: Developing a Direct Potable Reuse Framework

Duration: April 2014 – February 2015

This project, funded by the WaterReuse Association, began in March and is being conducted through an Expert Panel facilitated by Jeff Mosher at the **National Water Research Institute**. To date, one expert panel meeting has been held in

The objective of this project is to develop a framework focusing on issues such as public health protection, sufficient multiple barriers, risk assessment, water quality monitoring, and operation management that states can use to develop guidelines for Direct Potable Reuse.

Orange County, CA and another is expected to be held in November. A third panel meeting, along with a draft report, will be held in January in Washington DC where officials from EPA and other organizations will be invited to participate. This framework for direct potable reuse will focus on issues such as public health protection, sufficient multiple barriers, risk assessment, water quality monitoring, and operation management.

WRRF-14-10: Enhanced Pathogen and Pollutant Monitoring of the Colorado Water Municipal Water District Raw Water Production Facility at Big Spring, Texas**Objectives:**

- To expand the project scope and statistical accuracy of the state-of-the-art sampling campaign for the DPR plant at Big Spring, including trace chemical analyses for pharmaceuticals, hormones, and other compounds of interest, a full suite of pathogens (virus, protozoa, and bacteria), and a comprehensive set of both chemical and microbial indicators and surrogates.
- This large data set will enable the creation of a comprehensive, technically sound, and independent verification that potable reuse, as implemented at Big Spring and proposed by others, can be a safe and reliable source of high-quality drinking water.

Duration: August 2014 – November 2016

This project, led by Eva Steinle-Darling at **Carollo Engineers**, began in August. The team will soon provide an evaluation of the current treatment process and develop a testing protocol (part of the TWDB funded project).

This study will provide a comprehensive, technically sound, and independent verification that potable reuse, as implemented at Big Spring and proposed by others, can be a safe and reliable source of high-quality drinking water for the future.

WRRF-14-12: Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse

Duration: September 2014 – November 2016

This project will develop and examine a conceptual framework for a DPR facility for the Department of Drinking Water (DDW) and Expert Panel at the City of San Diego's newly upgraded Advanced Water Purification Demonstration Facility (AWPF). This conceptual framework will address issues beyond the treatment plant, such as source control, required operator training and certification, product water delivery and mixing strategies/requirements, as well as a plan to provide an alternative potable water supply in emergency scenarios and to ensure that extreme events do not compromise public health.

In September 2014, **Trussell Technologies** (PI Shane Trussell) initiated their DPR demonstration project in San Diego. This \$2.1M project is funded through a grant from the Department of Water Resources through San Diego County Water Authority. Later this year, Trussell will convene an IAP (independent advisory panel) workshop to develop a comprehensive test plan for DPR. The approved plan will be used for demonstration at San Diego's Advanced Water Purification Demonstration Facility for 52 weeks.

DPR Research approved for funding October 2014

Project #	Research Project Title	WRRF contribution	Project Manager	Research Focus	Objectives
WRRF-14-13	From Sewershed to Tap: Resiliency of Treatment Processes for DPR	\$200,000	Justin Mattingly	Regulatory	To assess the resiliency of unit treatment processes in DPR; To map the interdependency of unit treatment processes (trace failure and impacts); to determine DPR Schemes resilience to macro-failure events.
WRRF-14-14	Framework for Public Health Monitoring: Workshop	\$75,000	Kristan Cwalina	Regulatory, Community	To determine the specific kind of health data required to address the health issues adequately with implementation of DPR; To aid in the planning the means and methods used in collecting the required data; To recommend on necessary action to move the framework towards implementation
WRRF-14-15	Application of bioanalytical tools to assess biological responses associated with water at DPR facilities	\$300,000	Stefani McGregor	Utility	To apply bioanalytical tools (cell-based assays that measure the presence and toxicity of known and unknown chemicals in complex environmental samples) to a range of water samples (drinking water, IPR, DPR, etc) for biologically relevant endpoints to inform future water management options.
WRRF-14-16	Operational, Monitoring, and Response Data from Unit Processes in Full-Scale Water Treatment, IPR, and DPR	\$200,000	Justin Mattingly	Utility, Regulatory	To assess the failure mechanisms of potential DPR processes that could impact water quality/health risk and the range of times to failure for specific unit processes; To obtain qualitative operational information regarding failure/anomalous events to better understand failures; To develop recommendations for improving operational and response procedures and potential regulations
WRRF-14-17	White Paper on the Application of Molecular Methods for Pathogens for Potable Reuse	\$50,000	Stefani McGregor	Utility	To develop a white paper and assess the application and need for using molecular methods for pathogens in evaluating water quality in potable reuse facilities. The white paper will assess the potential applications as well as limitations and challenges to implementation in a purified water matrix.
WRRF-14-18	Ensuring stable microbial water quality in Direct Potable Reuse distribution systems	\$25,000	Stefani McGregor	Regulatory	To hold a workshop to better define/scope future research on the impacts various DPR water qualities would have on drinking water systems. Specifically, the emphasis is to understand how the microbial community changes as a result of treatment, storage, and piped distribution of water produced from a DPR facility.
WRRF-14-19	Predicting RO removal of toxicologically relevant unique organics	\$225,000	Kristan Cwalina	Utility	To predict removal efficiency of compounds identified by state or federal regulatory agencies of potential public health concern by RO; To predict removal of compounds that may be precursors of DBPs of potential health concern.

