Executive **Summary**

WATER ENVIRONMENT & REUSE FOUNDATION

Help for synthesizing the technical barriers to potable reuse

Potable Reuse Research Compilation: Synthesis of Findings (Reuse-15-01)

The Central Issue

Communities and decision makers seeking more information on potable reuse need an accessible resource for direct potable reuse (DPR) water projects. Utilities and municipalities interested in implementing DPR projects also need practical information. To make significant advancements and innovation in DPR research and technology, the public requires a better understanding of the value, needs, and challenges associated with using DPR to provide a safe, reliable source of drinking water.

Context and Background

WE&RF has a research portfolio of 34 projects which investigates different aspects of the technical feasibility of implementing DPR projects. This report summarizes and synthesizes key issues and findings from this research, as well as the results of complementary research, to provide a clear understanding of the state-of-the-art and state-of-the-science on DPR and to identify unknowns that may require further research.

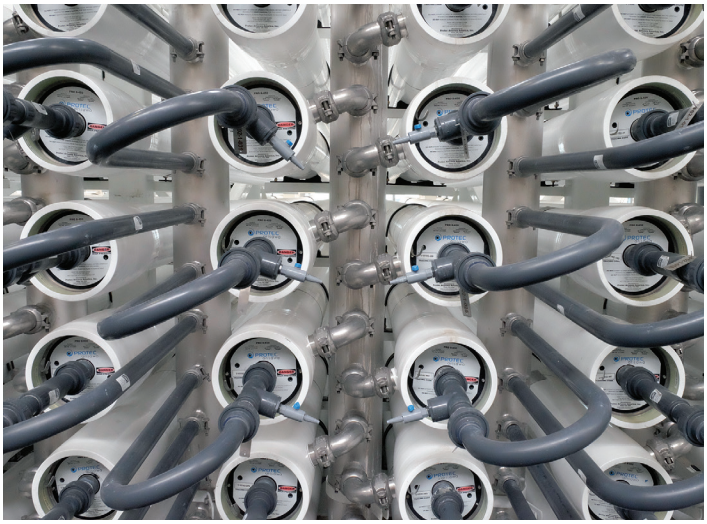
This synthesis project assembled the many technical topics of our DPR research into nine categories – and assigned experts in the field to compose summary pieces, pulling on the many applicable projects in a cohesive way. George Tchobanaglous (known for his work in reuse/potable reuse) is a Co-Principal Investigator who worked with each author and organized the chapters in a consistent way. This is the culmination of the potable reuse research that WE&RF has been leading for the last six years.

Findings and Conclusions

The topics addressed in this report include: source control, treatment trains, surrogates and log reduction credits for pathogens, pathogen monitoring, constituents of emerging concern, critical control points to monitor DPR systems, operation and maintenance of DPR facilities, operator training and certification, the resilience of DPR systems, and reliable and redundant treatment train performance.

Management and Policy Implications

This summary document will be important to regulators as they determine DPR and indirect potable reuse criteria and regulations. Decision makers can use this as a science-based rationale behind their processes. For example, the California State Water Resources Control Board (SCWRB) expert panel has used this synthesis document since it was in its draft in 2016. The SWRCB staff intends to use it in DPR regulation development starting in 2017. Additional states will likely find it equally beneficial.



End view of reverse osmosis membrane modules.

Pilot-scale plug-flow chlorine contact reactor. Images courtesy of George Tchobanoglous, Ph.D., P.E., NAE

Research Projects Included in the Direct Potable Reuse Research Initiative

Project Title	Principal Investigator(s)
Monitoring for Reliability and Process Control of Potable Reuse Applications	Ian Pepper, University of Arizona
Equivalency of Advanced Treatment Trains for Potable Reuse	R. Rhodes Trussell, Trussell Technologies, Inc.
Demonstrating the Benefits of Engineered Direct Potable Reuse versus Unintentional Indirect Potable Reuse Systems	Glen Boyd, The Cadmus Group, Inc.
Risk Reduction Principles for Direct Potable Reuse	Andrew Salveson, Carollo Engineers
Guidelines for Engineered Storage for Direct Potable Reuse	Andrew Salveson, Carollo Engineers
Methods for Integrity Testing of Nanofiltration and Reverse Osmosis Membranes	Joseph Jacangelo, MWH
Model Public Communication Plan for Advancing Direct Potable Reuse Acceptance	Mark Millan, Data Instincts
Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of Direct Potable Reuse Scheme	Troy Walker, Hazen & Sawyer
Evaluation of Source Water Control Options and the Impact of Selected Strategies on Direct Potable Reuse	Alan Rimer, Black & Veatch
Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse Systems	Troy Walker, Hazen & Sawyer
Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities	Channah Rock, University of Arizona
Blending Requirements for Water from Direct Potable Reuse Treatment Facilities	Andrew Salveson, Carollo Engineers
Integrated Management of Sensor Data for Real Time Decision Making and Response	Jeff Neeman, Black & Veatch
Establishing Additional Log Reduction Credits for Wastewater Treatment Plants	Zia Bukhari, American Water
Develop Methodology of Comprehensive (Fiscal/Triple Bottom Line) Analysis of Alternative Water Supply Projects Compared to Direct Potable Reuse	Ben Stanford, Hazen & Sawyer
Economics of Direct Potable Reuse	Robert Raucher, Stratus Consulting
Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring, Texas	Eva Steinle-Darling, Carollo Engineers
Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse	R. Shane Trussell, Trussell Technologies, Inc.
From Sewershed to Tap: Resiliency of Treatment Processes for Direct Potable Reuse	Sharon Waller, Sustainable Systems, LLC.
Framework for Public Health Monitoring: Workshop	Jeffrey Soller, Soller Environmental, LLC
Application of Bioanalytical Tools to Assess Biological Responses Associated with Water at Direct Potable Reuse Facilities	To Be Determined
Operational, Monitoring, and Response Data from Unit Processes in Full-Scale Water Treatment, Indirect Potable Reuse, and Direct Potable Reuse	Andrew Salveson, Carollo Engineers
White Paper on the Application of Molecular Methods for Pathogens for Potable Reuse	Krista Wigginton, University of Michigan
Ensuring Stable Microbial Water Quality in Direct Potable Reuse Distribution Systems	WRRF Workshop
Predicting Reverse Osmosis Removal of Toxicologically Relevant Unique Organics	Kerry Howe, University of New Mexico
Developing Direct Potable Reuse Guidelines	Jeffrey Mosher, National Water Research Institute
Direct Potable Reuse Research Compilation: Synthesis of Findings from Direct Potable Reuse Initiative Projects	Jeffrey Mosher, National Water Research Institute
Creating a Roadmap for Bioassay Implementation in Reuse Waters: A Cross Disciplinary Workshop	WRRF Workshop
Characterization and Treatability of Total Organic Carbon from Direct Potable Reuse Processes Compared to Surface Water Supplies	Larry Schimmoller, CH2M
Developing Curriculum and Content for Direct Potable Reuse Operator Training	Ben Stanford, Hazen & Sawyer
Molecular Methods for Measuring Pathogen Viability/Infectivity	To Be Determined
Optimization of Ozone/Biologically Activated Carbon Treatment Processes for Potable Reuse Applications	Zia Bukhari, American Water
Demonstration of High Quality Drinking Water Production Using Multi-Stage Ozone-Biological Filtration: A Comparison of Direct Potable Reuse with Existing Indirect Potable Reuse Practice	Kati Bell, CDM Smith, and Denise Funk, Gwinnett County Department of Water Resources
N-Nitrosodimethylamine (NDMA) Precursor Control Strategies for Direct Potable Reuse	Roshanak Aflaki, Los Angeles Sanitation

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