**NATIONAL WATER RESEARCH INSTITUTE**

# Volume II

# Final Report

*of the March 5, 2014, Conference Call Meeting of the*

# Expert Panel

*for the*

# California Department of Public Health (Agreement No. 13-21041)

*on*

# Development of Water Recycling Criteria for Indirect Potable Reuse through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse

June 12, 2014
Fountain Valley, California

www.nwri-usa.org/ca-panel.htm

## ABOUT NWRI

A 501c3 nonprofit organization, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

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Gina Melin Vartanian, Editor

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## ACKNOWLEDGMENTS

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The Panel would like to thank CDPH staff for the information, materials, and suggestions received from CDPH as part of the first Panel Meeting, which is the focus of this Panel Report. In particular, the Panel thanks Mr. Randy Barnard, Mr. Mark Bartson, Mr. Brian Bernados, Mr. Bruce Burton, Mr. Robert Hultquist, and Dr. David Spath of CDPH for their assistance. The Panel also appreciates the support of Mr. Bruce Burton, Chief of the Northern California Drinking Field Operations Branch, who serves as the CDPH project representative on this effort.

In addition, the Panel thanks the National Water Research Institute for administering and organizing the Panel's efforts. The Panel would also like to recognize the WateReuse Research Foundation, WateReuse California, and Water Research Foundation for participating in the first Panel Meeting and providing valuable information on current and future potable reuse research projects.

## DISCLAIMER

This report was prepared by an NWRI Expert Panel (Panel), which is administered by the National Water Research Institute (NWRI). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

**CONTENTS**

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## Volume I



## Volume II

# ITEM 1:

# PRESENTATION SLIDES FROM THE MARCH 5, 2014, WEB-ENABLED CONFERENCE CALL MEETING OF THE EXPERT PANEL

# NWRI Expert Panel

## Development of Water Recycling Criteria for IPR through Surface Water Augmentation and the Feasibility of Developing Criteria for DPR

for the California Department of Public Health

NWRI

Conference Call Meeting
March 5, 2014
9:00 am to 1:00 pm (PST)

CDPH California Department of PublicHealth

# Welcome (9:00 – 9:10 am)

- **Welcome and Introductions**
  - **Jeff Mosher, NWRI**

- **Proposed ground rules:**
  - **Mute phone if possible**
  - **In GoToMeeting use "chat" to ask questions**
  - **Q&A after the presentations**

2

# Attendees

- **Expert Panel Members**
  - CHAIR: Rhodes Trussell, Trussell Technologies
  - Michael Anderson, UC Riverside
  - Dick Bull, MoBull Consulting
  - Jörg Drewes, Technische Universität München




3

# Attendees

- **Expert Panel Members**
  - Chuck Haas, Drexel University
  - Walter Jakubowski, WaltJay Consulting
  - Perry McCarty, Stanford University
  - Kara Nelson, UC Berkeley




4

# Attendees

- **Expert Panel Members**
  - Adam Olivieri, EOA, Inc.
  - Joan Rose, Michigan State University
  - David Sedlak, UC Berkeley
  - Tim Wade, US EPA




5

# Attendees

- **CDPH Staff:**
  - **Bruce Burton, Chief, Northern California Drinking Field Operations Branch**
  - **Randy Barnard, RW Treatment Specialist**
  - **Mark Bartson, Chief, Technical Operations Section**
  - **Brian Bernados, Technical Specialist**
  - **Bob Hultquist, Drinking Water Program Expert**
  - **Dave Spath, Drinking Water Program Expert**

6

# Attendees

- **WateReuse Representatives**
  - Stefani McGregor, WateReuse Research Foundation
  - Julie Minton, WateReuse Research Foundation
  - Justin Mattingly, WateReuse Research Foundation
  - David Smith, WateReuse California
  - Mark LeChevallier, American Water (WRRF RAC Chair)
- **Water Research Foundation**
  - Chris Rayburn, Water Research Foundation
- **NWRI Staff**
  - Jeff Mosher, Executive Director
  - Brandi Caskey, Events Manager
  - Gina Vartanian, Communications Manager

7

# Program (9:10 – 9:20 am)

- **Review Purpose of Meeting and Meeting Agenda**
  - Rhodes Trussell, Panel Chair

8

# Meeting Objectives

- **Provide an overview of the CDPH's mandate regarding the Expert Panel.**
- **Review the Panel's scope of work.**
- **Review DPR research efforts to date and future research needs.**

9

# Agenda

- **Overview of Panel Process**
- **CDPH Perspective**
  - **Statuary Mandates and Specific Tasks of the Panel**
  - **Briefing on Potable Reuse in California**
- **Review of DPR Research**
  - **WateReuse DPR Initiative and "Research Plan" Overview**
  - **Overview of Current DPR Research Projects**
  - **Discussion on DPR Research**
- **Closed Panel Discussion**

10

## CDPH Perspective and Panel Overview

## CDPH Perspective (9:20 – 9:35 am)

- **Statuary Mandates and Specific Tasks of the Panel**
  - **Bruce Burton, CDPH**

# POTABLE REUSE STATUTORY MANDATES AND TASKS

## STATUTORY MANDATE
## WATER CODE SECTIONS 13560-13569

- Expert Panel
  - Assess DPR Research Needs
  - Advise on Development of IPR through Surface Water Augmentation (SWA). Make a Determination as to Whether Proposed Criteria for SWA are Adequately Protective of Public Health
  - Advise on the Feasibility of Developing Uniform Criteria for Direct Potable Reuse

## STATUTORY MANDATE
## WATER CODE SECTIONS 13560-13569

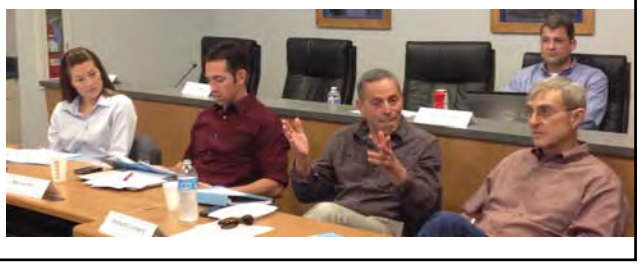
- California Department of Public Health
  - Adopt Groundwater Replenishment Regulations by December 31, 2013
  - Adopt SWA Regulations by December 31, 2016
  - Report to the Legislature by December 31, 2016 on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse

## STATUTORY MANDATE
## WATER CODE SECTIONS 13560-13569

- Advisory Group
  - Advise the Expert Panel on the development of uniform water recycling criteria for DPR criteria
  - Advise the Department on the feasibility of developing uniform water recycling criteria for DPR

# Panel Overview (9:35 – 9:50 am)

- Description of Expert Panel Process
  - Jeff Mosher, NWRI



# Expert Panel - Areas

- Areas of Expertise:
  - Chair
  - Toxicologist
  - Wastewater treatment engineering
  - Water treatment engineering
  - Epidemiology
  - Microbiology
  - Chemistry
  - Multi-barrier system reliability
  - Microbial risk assessment
  - Limnology

18

# Expert Panel

- **Charge (Tasks):**

1. **Assess what, if any, additional areas of research are needed for establishing criteria for DPR**
2. **Advise CDPH on public health issues and scientific and technical matters regarding the development of surface water augmentation (IPR) criteria**
3. **Advise CDPH on public health issues and scientific and technical matters regarding the feasibility of developing criteria for DPR**

19

# Phase 1 – Approach

- **Review Research Plan(s) (Task 1)**
  - **DPR research is ongoing and more research is planned**
  - **To ensure funds are focused on critical knowledge gaps, the panel will be asked to review research plans**
- **Surface water augmentation criteria (Task 2)**
  - **Review initial CDPH draft criteria (and rationale)**
  - **Review: City of San Diego efforts, research, monitoring data, demonstration studies, epi studies, risk assessments, state reports, NRC study, etc.**
  - **Guiding principal: protection of public health**

20

# Phase 2 (DPR) – Approach

- Review and evaluate feasibility of criteria for DPR (Task 3)
  - Goal: Protect public health
  - To determine feasibility review:
    - Treatment technologies
    - Multiple barriers needed
    - Information on health effects
    - Failure of treatment systems (how to react)
    - Monitoring
    - Other scientific or technical issues
    - Additional research needed
    - Concerns raised by Advisory Panel?

21

# Expert Panel - Schedule

- Phase 1
  - Review DPR Research Plan(s) (Task 1)
    - No legislated schedule
  - Address surface water augmentation criteria (Task 2)
    - By December 31, 2016
- Phase 2
  - Review and evaluate feasibility of criteria for DPR (Task 3)
    - Product: Report to legislature
    - Draft Recommendations Report – June 30, 2016
    - Public review draft – September 1, 2016
    - Final Report – December 31, 2016

22

# Panel Process

- NWRI coordinates with CDPH and Panel Chair
  1. CDPH will develop "scope of work"
  2. NWRI and Chair: Develop proposed approach
- Review approach with Panel (at first meeting)
  - Finalize approach
- General:
  - Use of Panel meetings (open and closed sessions)
    - 5 meetings in first phase
  - Use of web-enabled conference calls
  - Make assignments for between meeting efforts
  - "Advisory Panel" input

23

# Panel Outcomes

- "Panel reports" representing a consensus of the panel
- By Task:
  1. Review of DPR research – letter/memo report
  2. Review of "Surface Water Augmentation Criteria" – Panel Report
  3. Review of "Feasibility of Criteria for DPR" – Panel Report

24

## Advisory Committee on DPR

- **At least 9 representatives in these areas:**
  - Water and wastewater agencies
  - Local public health officers
  - Environmental organizations
  - Environmental justice organizations
  - Public health nongovernmental organizations
  - CDPH
  - State Water Resources Control Board
  - U.S. EPA
  - Ratepayer or taxpayer advocate organizations
  - Business community

25

## Advisory Committee Representatives

| | |
|---|---|
| Ray Tremblay | LACSD |
| Jim Fiedler | Santa Clara Valley Water District |
| Marsi Steirer | City of San Diego |
| Mike Wehner | Orange County Water District |
| Al Lau | Padre Dam Municipal Water District |
| Keith Solar | San Diego County Taxpayers Association |
| Traci Minamide | LA Bureau of Sanitation |
| Garry Brown | Orange County Coastkeeper |
| Andria Ventura | Clean Water Action |
| Conner Everts | Environmental Justice Coalition for Water |
| Shahla Farahnak | SWRCB |
| Alisa Reinhardt | San Diego Regional Chamber of Commerce |
| Charles Mosher | Mariposa County Health Department |
| Bruce Macler | U.S. EPA |
| Mark Bartson | CDPH |

26

# Advisory Committee (CDPH)

- **Charge:**
  - **Advise the Expert Panel regarding investigation of the feasibility of developing criteria for DPR**
  - **Consult in selecting members of the Expert Panel**
  - **Review the Panel's draft report**
- **Open meetings**
  - **Bagley-Keen Meeting Act Requirements**
  - **Public participation encouraged**
- **Schedule**
  - **Initial meeting: February 21**
  - **Discuss organization/operation of Advisory Group**

27

# CDPH Perspective (9:50 to 10:20 am)

- **Briefing on Potable Reuse in California**
  - **Bob Hultquist and Brian Bernados, CDPH**

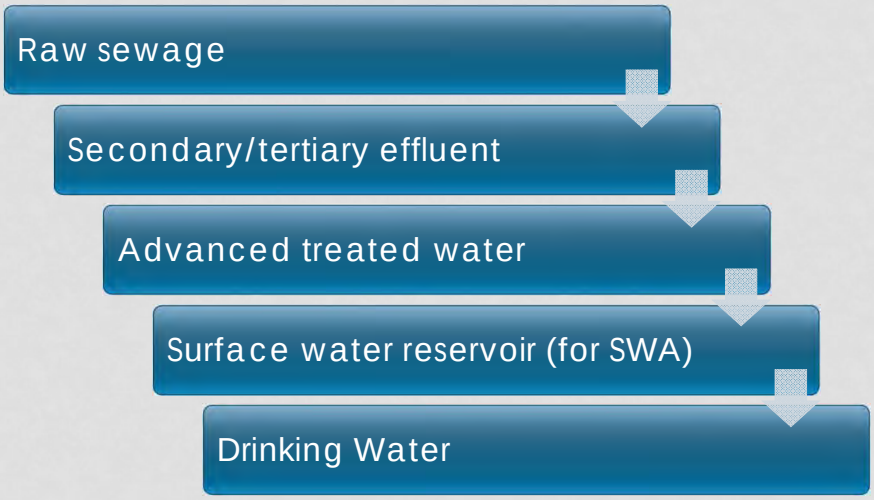
28

# REGULATING POTABLE REUSE

# CALIFORNIA SAFE DRINKING WATER ACT

- Pure, wholesome, potable, and healthy water
- Evaluate and permit each source
- Chemical Standards (MCLs)
- For surface water augmentation and direct potable reuse - Surface Water Treatment Rule (SWTR)
  - A water system "using an approved surface water shall provide multibarrier treatment necessary to reliably protect users from the adverse health effects of microbiological contaminants …"
  - Organism log reductions are determined as part of source approval process

## TRANSITION: CWA to SDWA when "Approved Source"



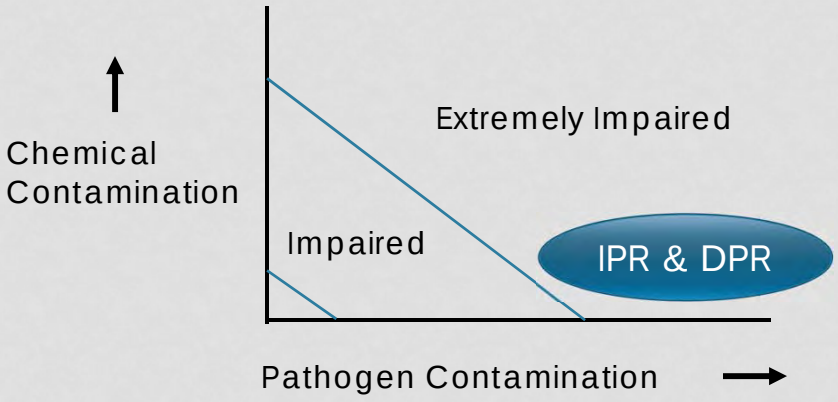

## INDIRECT POTABLE REUSE REGULATORY SCHEME

- Clean Water Act regulators:
  - Regulate the reuse project to assure no impairment of the receiving groundwater of surface water
  - Groundwater recharge regulated in recycling criteria
- Drinking Water Regulators:
  - Enforce standard provisions of the SDWA
  - For SWA much of the regulation will be in the SWTR

# A POSSIBLE REGULATORY SCHEME FOR DPR

- Clean Water Act regulators could regulate what they have the authority, expertise, and operator certification program for:
  - Source control for the collection system
  - Treatment through secondary or tertiary
  - Disposition of inadequately treated wastewater
- Drinking Water Regulators could:
  - Approve secondary or tertiary effluent meeting the CWA regulators permit as the "approved" surface water source
  - Specify advanced treatment and monitoring in the water system permit as they would for any impaired or extremely impaired source

# SOURCE QUALITY



## POTABLE REUSE REGULATION PRINCIPLES

- Make a "safe" drinking water
- Low tolerable risk
  - $10^{-4}$ annual risk of infection
  - Drinking water standards
  - Unregulated chemical controlled to match good conventional supplies
- Low risk of failure
  - Multiple barriers for contaminants
  - Appropriate monitoring

35

## TRACE ORGANIC CHEMICALS

- The advanced treatment in the IPR draft regulation is effective where 100% reclaimed water reaches a drinking water source and should be good for DPR
  - The IPR advanced treatment is RO and AOP
  - Treatment alternatives may be allowed if they assure the same level of health protection
- Chronic risk
  - Have time to react to a treatment problem
  - IPR – provided by travel time
  - DPR –does the risk from a failure justify additional measures?

## PATHOGENIC MICROORGANISMS

- Acute risk
- Set a log reduction treatment requirement Raw sewage to finished drinking water
  - 12-log Virus
  - 10-log *Giardia*
  - 10-log *Cryptosporidium*
  - Based on high sewage levels and USEPA drinking levels for a $10^{-4}$ risk

37

## PATHOGEN CONTROL APPROACHES

- We could assure safe water by providing:
  - Real-time monitoring of organism reduction for the required barriers,

    or, possibly

  - Best available monitoring and redundant barriers to provide extra log reduction capacity to compensate for monitoring limitations

## PATHOGENS CONTROL QUESTIONS

- Is the available monitoring sensitive and rapid enough to tell us when the organism reduction goal is not being met?
- How do we measure the overall reliability of the treatment scheme?
- How consistently must the treatment meet the organism log-reduction goal?
- Multiple redundant barriers minimize the chance of a complete failure of treatment -
  how do we determine the necessary number and capability of the redundant barriers?

## SUMMARY
## A POSSIBLE DPR SCHEME

- Regulate the critical treatment under the SDWA
- Focus on acute risks (pathogens)
- Continuously verify treatment performance
- Provide sufficient barriers with:
  - Real-time organism reduction verification monitoring
    or
  - Best available monitoring with redundant barriers to strictly restrict the chance of inadequately treated water
- Provide a fail➔safe response to a system problem

## RESEARCH TO SUPPORT REGULATION

- Clarity in Rulemaking
- It must be clear whether or not a project is in compliance with the criteria.
- The criteria should rely on specific, objective measures
- To support regulation - research into treatment should correlate contaminant reduction performance with readily measured, enforceable, performance indicators.

## Questions & Research Issues

Adenovirus

Reliability

Engineered storage buffer

Pathogen surrogates

Is it Safe?

March 5, 2014

Brian Bernados, P.E.
Technical Operations Section
Brian.bernados@cdph.ca.gov

Adenovirus and Public Health

- Adenovirus are often a question, especially involving UV treatment
- Is the high concentration of adenoviruses in sewage a concern?
- Since there are various adenoviruses, should enteric adenoviruses AD40 and 41 be the focus?

## Adenovirus or MS-2?

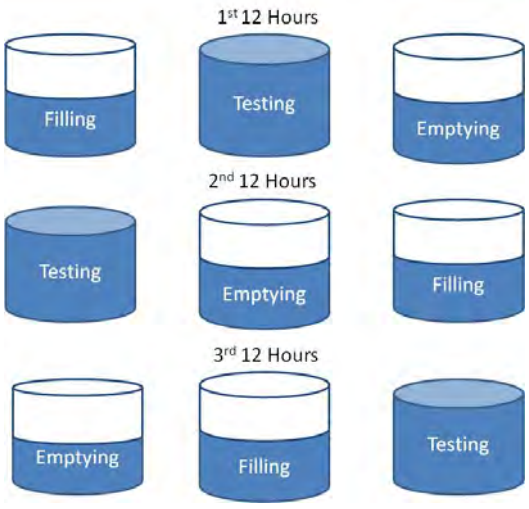
- Question - ". . . 6-log credit for virus through UV (after RO), do I . . . target 6-log of polio or do I . . . target 6-log adenovirus??"
- My Response: In the EPA UVDGM, adenoviruses needs 186 $mJ/cm^2$ for 4-log . . . recent studies have shown high concentrations of adenovirus in wastewater.
- If FAT, the UV should be operated at a very, very high dose.
- AOP is generally monitored via EE/O, but current FAT projects are not directly tracking UV dose.

## engineered storage buffers

- Surface water treatment plants typically have clearwells
- For DPR, the ESB replaces the natural barrier
- It is assumed that treatment processes failure is inevitable, and ESBs address this through monitoring and storage time.
- Some experts consider ESB important
- Should ESB be required?

## ESB Three tanks?

- Would a three-tank process as proposed in the WRRF 11-10 be recommended?



## Reformation of NDMA and other DPBs

- Could long contact times with free chlorine cause reformation of NDMA?
- What about other regulated DPBs?
- Would potential future DBP contaminants be a problem for DPR?

## Online monitoring for pathogens

- The status of online monitoring for pathogens
- Current sensitivity is inadequate
- Cannot directly monitor pathogens at the levels deemed safe for human consumption.
- Therefore, what makes a suitable surrogate?
- What alternative surrogates should be considered and/or developed?

## Resolution & Sensitivity Issue

- As an example, EPA LT2 SWTR defines:
- Resolution: the size of a breach from a direct integrity test (DIT)
- Resolution for Cryptosporidium = 3 µm.
- Sensitivity: max LRV reliably verified by the DIT
- The sensitivity of a DIT must => Cryptosporidium removal credit awarded
- Virus resolution = 0.01 µm vs. 3 µm.
- Need a test pressure => 4,000 psi (+/-) vs. 15 psi
- In general, for any contaminant, what is the resolution & sensitivity needed for an instrument?

49

## Safety of DPR

- What techniques / methodologies can be used for the assessment of DPR water safety
- Water are the proper metrics for “safety”?
- That is how can you measure safety?

## AOP & By-products

- Is there is the concern over their AOP metabolites or by-products of treatment.
- For DPR, should GAC or biological treatment follow to ensure AOP degradates are removed?
- For DPR, is another removal barrier, besides AOP is necessary compounds that are not easily oxidized?

## PHGs

- Since DPR is bridging the gap to drinking water, what is the relevance of CA's Public Health Goals?
- If contaminants > PHGs must be in annual Consumer Confidence Reports.
- Some must provide a report about health risks if > PHG and cost to meet the PHG, and hold a public hearing.

## Other Research Needs

- A direct integrity test (DIT) for RO should be developed
  - online sensor with sensitivity and resolution of viruses
- Adequate real-time online monitoring pathogens
- How many sensors are needed
- Do we need new epidemiological studies?

53

## Review of DPR Research

# DPR Research (10:20 – 10:35 am)

- **WateReuse DPR Initiative and "Research Plan" Overview**
  - **David Smith, WateReuse California**

55

# Direct Potable Reuse Initiative

## NWRI DPR Panel for CDPH

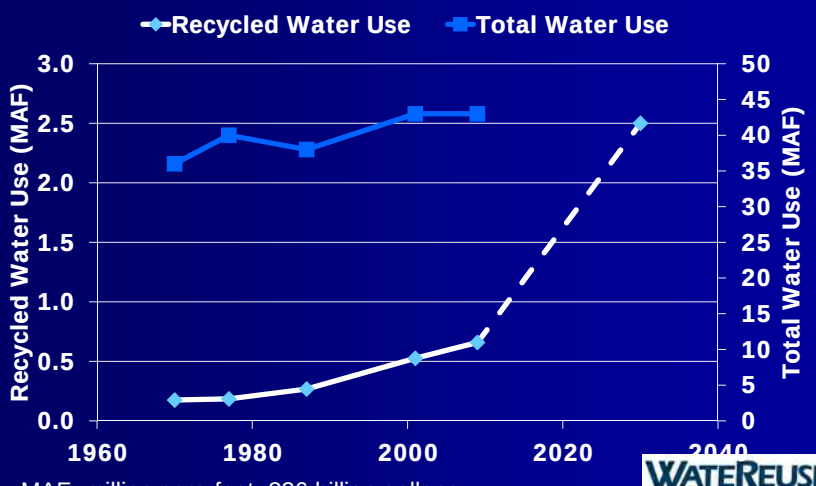
March 5, 2014

David W. Smith, PhD
Managing Director
WateReuse California
dsmith@watereuse.org
916 669-8401

# Why DPR?

- State recycling goal

# State's Goal for Requires Additional Recycling




MAF=million acre-feet=326 billion gallons

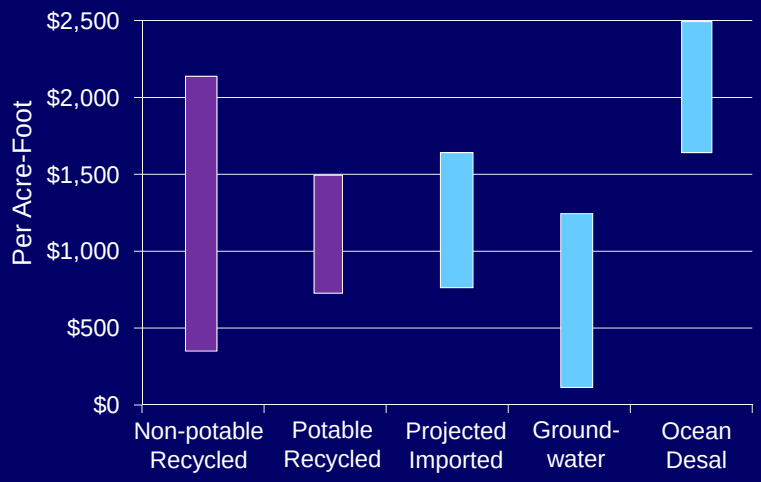
# Why DPR?

- State recycling goal
- Legislation
  - SB 565 would have capped ocean discharge
  - SB 918/SB 322 require DPR regulation feasibility review, and expert panel

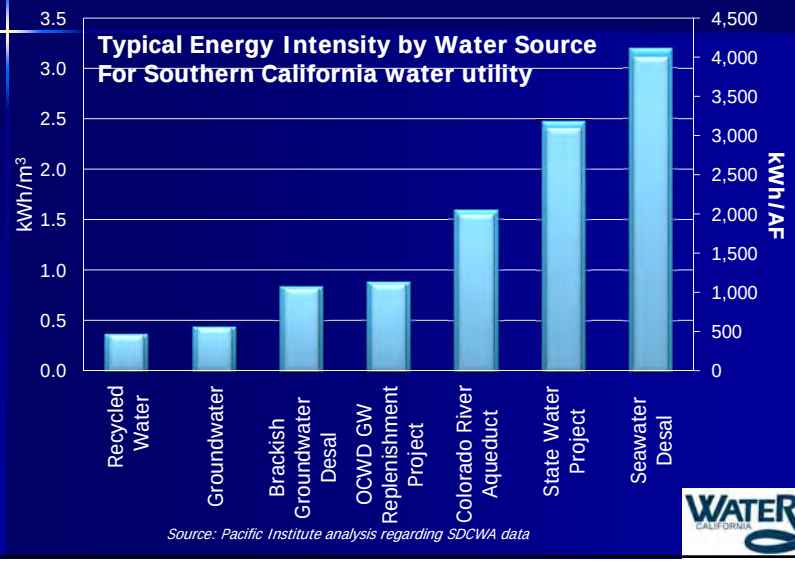
# Why DPR?

- State recycling goal
- Legislation
  - SB 565 would have capped ocean discharge
  - SB 918/SB 322 require DPR regulation feasibility review, and expert panel
- Energy and cost

# Recycled Water Is Cost-Competitive




# Energy Conservation Benefits of Potable Reuse



## DPR Initiative

- Partnership of WRRF and WRCA
- Goals
  - Rigorous research (WRRF)
  - Stakeholder awareness → acceptance (WRCA)
  - Regulations for DPR (DPH/SWRCB)
- Initiative Budget: $8-10 million over three years

## DPR Initiative Status

- Business Plan developed
- Research
  - Plan developed, Expert Panel review needed
  - Research projects in progress
- Education and outreach activities

# DPR Research (10:35 – 11:30 am)

- **Overview of Current DPR Research Projects**
  - Julie Minton, WateReuse Research Foundation
  - Stefani McGregor, WateReuse Research Foundation
  - Justin Mattingly, WateReuse Research Foundation



WATEREUSE RESEARCH

## Questions for Panel on "Research Plan"

1. Does the Research Plan appropriately define the needed DPR research?
2. Is the framework (Section 2) presented in the Plan appropriate (i.e., regulatory, utility, and community concerns)?
3. Can the Panel identify any substantial gaps in the research framework, including the current research (Appendix B) and proposed future research (Section 4)?
4. Does the Panel have other comments for WateReuse as it implements the Plan?
5. How would the Panel like to be updated in the future on the status of the research efforts?

66

# Overview of Current DPR Research

CDPH Expert Panel
Conference Call
March 5, 2014



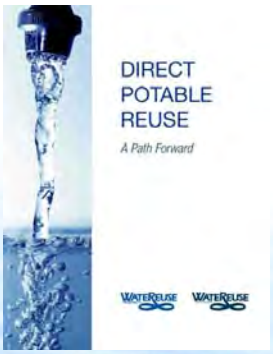
## Research Path to Achieve DPR Initiative Goal

To overcome the regulatory, scientific, technical, and attitudinal barriers to DPR by undertaking three main tasks:

- Conduct rigorous scientific research
- Communicate the research findings through public awareness programs
- Work with regulatory authorities to facilitate DPR implementation by local water utilities

## WRRF DPR Program

- DPR Specific Research Initiated in 2011 Based off of:
  - DPR: A Path Forward (2010)
  - NRC Report (2012)
  - DPR Workshop (12/12/12)




WATEREUSE RESEARCH



## Research Framework

1. Regulatory Concerns
   - How to achieve treatment and process reliability through redundancy, robustness, and resilience
2. Utility Concerns
   - Address economic and technical feasibility
3. Community Concerns
   - Awareness, Education, and Acceptance

WATEREUSE RESEARCH

# Solid Foundation of DPR Research

| Project # | Research Project Title | Principal Investigator | Research Focus |
|---|---|---|---|
| WRRF-11-01 | Monitoring for Reliability and Process Control of Potable Reuse Applications | Ian Pepper, University of Arizona | Regulatory - Process Reliability |
| WRRF-11-02 | Equivalency of Advanced Treatment Trains for Potable Reuse | Rhodes Trussell, Trussell Technologies | Regulatory - Treatment |
| WRRF-11-05 | Demonstrating the Benefits of Engineered Direct Potable Reuse versus Unintentional Indirect Potable Reuse Systems | Glen Boyd, The Cadmus Group Inc | Community, Regulatory |
| WRRF-11-10 | Evaluation of Risk Reduction Principles for Direct Potable Reuse | Andy Salveson, Carollo Engineers | Regulatory - Treatment |
| WRRF-12-06 | Guidelines for Engineered Storage for Direct Potable Reuse | Andy Salveson, Carollo Engineers | Regulatory - Treatment |
| WRRF-12-07 | Methods for Integrity Testing of NF and RO Membranes | Joe Jacangelo, MWH | Regulatory - Process Reliability |

= over $3.8 million

•71

# 2013 DPR Program

| Project # | Research Project Title | Principal Investigator | Research Focus |
|---|---|---|---|
| WRRF-13-02 | Model Public Communication Plan for Advancing DPR Acceptance | Mark Millan, Data Instincts; Patsy Tennyson, Katz & Associates | Community |
| WRRF-13-03 | Critical Control Point assessment to quantify robustness and reliability of multiple treatment barriers of DPR scheme | Troy Walker, Hazen & Sawyer | Regulatory - Process Reliability |
| WRRF-13-12 | Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR | TBD | Utility, Regulatory |
| WRRF-13-13 | Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse (DPR) Systems | TBD | Utility |
| WRRF-13-15 (WRF4536) | Blending Requirements for Water from Direct Potable Reuse Treatment Facilities | TBD in March (managed by WRF) | Utility |
| WRRF-13-14 (WRF4508) | Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities | TBD in March (managed by WRF) | Utility, Regulatory |

= $1 million invested by WRRF, $600,000 by WRF

•72

# 2014 DPR Program

| Project # | Research Project Title | Principal Investigator | Research Focus |
|---|---|---|---|
| WRRF-14-01 | Integrated Management of Sensor Data for Real Time Decision Making and Response | TBD | Regulatory - Process Reliability |
| WRRF-14-02 | Establishing additional log reduction credits for WWTPs | TBD | Regulatory - Treatment |
| WRRF-14-03 | Develop Methology of comprehensive (fiscal/triple bottom line) analysis of alternative water supply projects compared to DPR | TBD | Utility |
| WRRF-14-04 | DPR Rapid Response Messages | TBD | Community |
| WRRF-14-05 | Screening high risk chemicals potential of passage through RO/AOP | TBD | Regulatory - Treatment |

= $1.2+ million invested by WRRF

WATEREUSE RESEARCH

•73

# Research Focus: Regulatory Concerns – Treatment & Process Reliability

Reliability

- *Develop concepts that draw upon the existing regulatory framework for drinking water to establish the definition of reliability in potable reuse*
- *Define treatment requirements for chemicals and pathogens of health significance*
- *Develop on-line monitoring strategies for each unit process and demonstrate application*

Redundancy

- *Define the benefits of the multi-barrier concept to ensure public health protection*
- *Describe the balance between redundancy, monitoring, and storage, and how they work together to ensure reliability*
- *Define what level of redundant (supernumerary) treatment is necessary to ensure reliability, particularly for CDPH Path 2*
- *Design of Engineered Buffers*

Robustness

- *Develop guidelines for an acceptable DPR source water*
- *Determine robust treatment schemes that are best suited to address unknown challenges*
- *Develop strategy to determine how to quantify the sense of the unknown with CECs*

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Resilience

- *Determine appropriate resilient strategies to ensure reliability in extreme events*

•74

# Regulatory Track 1: Treatment and Engineered Storage

Current Research Questions Focus on:

- Treatment Train Reliability
- Design of Buffers and Engineered Storage Systems
- Regulatory Requirements
- Identifying Unknown Health Risks



# Research Focus: Treatment Train Reliability

## Equivalency of Advanced Treatment Trains for Potable Reuse

WRRF-11-02: Trussell Technologies

**Research Questions**

- What criteria should be used to judge the equivalency of potable reuse trains?
- What treatment trains are capable of meeting these criteria?

**Projected Outcomes**

- Determine what modifications are necessary to treatment trains to satisfy the more stringent public health criteria for DPR.
- Project will result in a computer model (toolbox) that delivers information on integrated water reuse treatment trains for DPR.
- Using initial findings from the toolbox several treatment trains have been identified for near-full-scale direct potable reuse testing
- Final result will be a report summarizing the results from the large-scale validation of the potable reuse treatment trains.

# Research Focus:
# Treatment Train Reliability

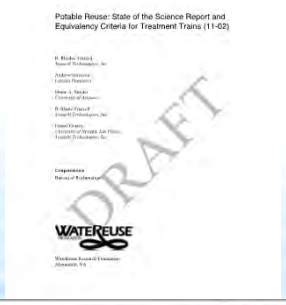
## Equivalency of Advanced Treatment Trains for Potable Reuse

WRRF-11-02: Trussell Technologies

**Preliminary Findings**

- One-size-fits-all treatment approach not effective
- Public health protection = primary goal
- Needs addressed by WRRF 11-02:
  - Develop criteria to evaluate treatment trains
  - Utilize criteria to identify PR alternatives
- Multiple treatment trains can provide equivalent public health protection

*Work is expected to be complete in July 2014 with publication in 2015*





77

# Research Focus:
# Treatment Train Reliability

## Evaluation of Risk Reduction Principles to Direct Potable Reuse

WRRF-11-10: Andy Salveson, Carollo Engineers

Objective: To identify how risk reduction and response concepts developed in other industries can be adapted and applied to DPR systems. The project evaluated the value of the environmental buffer and investigated ways of replacing it (for example, through multi-barrier or redundant treatment).

***"The primary benefit of an environmental buffer is to provide time to react should treatment be inadequate due to process failure or other factors"***
***– Direct Potable Reuse, A Path Forward***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78

78

# Research Focus: Treatment Train Reliability

## Evaluation of Risk Reduction Principles to Direct Potable Reuse

WRRF-11-10: Andy Salveson, Carollo Engineers

Risk

Focus on eliminating acute risk due to treatment failures.

Design & Operation

Other process trains besides "FAT" should be considered.

Focus on the goal and not specific processes.

Monitoring

Push to develop better monitoring tools.

Human Element

Need motivation, training, and focus.

Cost

Driven by treatment train, P&P, & storage.

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# Research Focus: Design of Buffers and Engineered Storage Systems

## Guidelines for Engineered Storage Systems

WRRF-12-06: Andy Salveson, Carollo Engineers

- **Objective**: To develop recommendations for optimizing engineered storage systems for direct potable reuse, through examining current practices and existing research to generate a guidance document and report.
  - Designing Engineered Storage
    - Examining parameters such as retention time, response time, and costs
  - Task 3 – Examining Public Perception
    - What does the public know/think about the engineered storage buffer and DPR?
  - Task 4 – IPR to DPR Transition Case Studies

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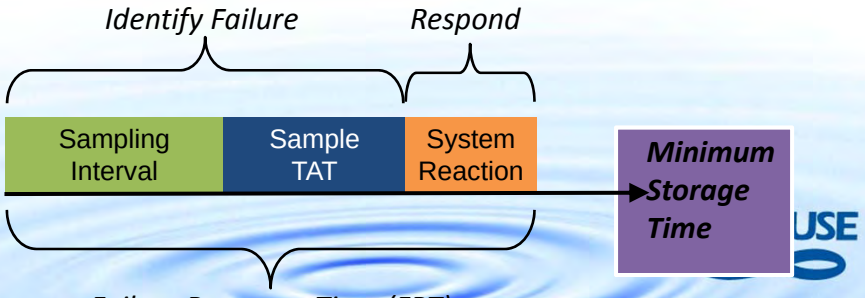
# Research Focus: Design of Buffers and Engineered Storage Systems

Guidelines for Engineered Storage Systems

WRRF-12-06: Andy Salveson, Carollo Engineers

**Basic Framework for Sizing Engineered Storage System: Failure Response Time**

For each individual process:




•81

# Research Focus: Regulatory Requirements

Establishing Pathogen Log Reduction Credits for WWTPs

WRRF-14-02

**Objectives:**

- 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.

•82

# Research Focus: Identifying Unknown Health Risks

## Screening High Risk Chemicals Potential Passage Through RO/AOP

WRRF-14-05

The final report will summarize the screening process aimed at identify potential for registered chemicals to pass RO-UV/$H_2O_2$ barriers in a DPR system, including identification of potential compounds (inorganic and organic) that are likely to occur, pass treatment, pose health risk or pose aesthetic risks to consumers.

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# Regulatory Track 2: DPR Process Reliability

Current Research Questions Focus on:

- Reliability of "systems"/multiple barriers
- Reliability of existing unit processes
- Operational barriers including sensors
- Monitoring

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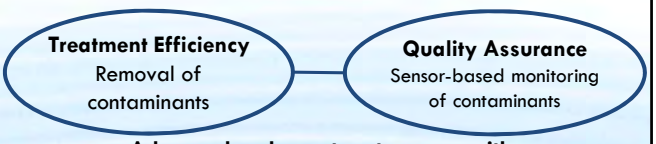
# Research Focus:
# Reliability and Monitoring

## Monitoring for Reliability and Process Control of Potable Reuse Applications

WRRF-11-01: Ian Pepper, Shane Snyder – U of Arizona

*Objective of identifying, evaluating, testing, and validating monitoring systems to assure the public safety and reliability of potable reuse. Project is specifically focused on real-time or near real-time monitoring for the removal of trace organics and biological contaminants.*

***The ultimate goal is to advance smart water reuse systems that are self-monitoring and self-healing, and gain public trust through demonstrated reliability and security.***




**Advanced and smart water reuse with self-monitoring and self-healing systems**

**Water Reuse: Safe and Reliable Potable Water**

•85

# Research Focus:
# Reliability and Monitoring

## Standard Methods for Integrity Monitoring and On-line Monitoring of NF and RO Membranes

WRRF-12-07: Joe Jacangelo, MWH

**Reason for the project:**

- NF and RO integrity can be compromised at several system locations during manufacturing, transport, installation and operation.
- There are no integrity monitoring methods for NF and RO systems employed at the full-scale that directly demonstrate microorganism removal.
- Several integrity testing methods have been evaluated for NF and RO membranes but with limitations. It is important to develop a method that is not only practical but is also cost effective

•86

# Research Focus:
# Reliability and Monitoring

## Standard Methods for Integrity Monitoring and On-line Monitoring of NF and RO Membranes

WRRF-12-07: Joe Jacangelo, MWH

**Project Goal and Significance**

- Develop a scientifically proven method for integrity monitoring of NF and RO membranes for a 4 log validation of microorganisms.
- The development of such a method and protocol will assist in its adoption as an industry standard for approval by regulatory agencies to provide microbial removal credits for NF and RO systems.

*Work Completion date ~ January 2016, Publication end 2016*

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•87

# Research Focus:
# Operational Barriers

## Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme

WRRF-13-03: Troy Walker, Ben Stanford – Hazen & Sawyer

**Objectives**

- Conduct hazard assessment for key unit operations for two or more direct potable reuse (DPR) treatment trains, including the following:
  - MF/UF – RO – UV/H2O2 – Cl2 – Engineered Storage
  - O3 – BAC – GAC – UV – Cl2 – Engineered Storage
- 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.
- 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.

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•88

# Research Focus:
# Operational Barriers

## Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme

WRRF-13-03: Troy Walker, Ben Stanford – Hazen & Sawyer

**Preliminary Results:** The first Hazard Analysis and Critical Control Points (HACCP) workshop was held on 2/25 – 2/26

- First determination of critical control points and monitoring options determined.
- Critical Control Points (CCP)for both processes (FAT membrane treatment and Ozone/BAC/GAC/UV) identified.
- Key items for utility data gathering identified and actions for collection.
- Detailed water quality risk assessment to be undertaken separately (more value for the team to work on CCP selection).

89

# Research Focus:
# Sensors and Monitoring

## Integrated Management of Sensor Data for Real Time Decision Making and Response

WRRF-14-01

**Objectives**

- Develop an operation support tool that integrates diverse sensors within the treatment process for immediate feedback/alerts. Integrate existing sensors as an early warning system for a Direct Potable Reuse (DPR) treatment process to provide:
  - Real time sensor network for tracking system performance and key quality parameters,
  - A tool for early detection of system anomalies prior to any compromise in water quality.

**Projected Outcomes**

- A decision support tool will be developed to integrate the signals from sensors
- The tool will be applied to a full scale or pilot scale plant to demonstrate a range of operational challenges and validate output.

90

# Research Focus: Utility Concerns

**Economic and Technical**

- *Identify methods to reduce the cost (and energy intensity) of DPR treatment*
- *Identify alternative treatment trains that meet public health criteria*
- *Identify non-RO DPR treatment options to eliminate need for brine disposal*
- *Develop DPR training and operational plans*
- *Product water aesthetics: taste and odor*

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•91

# Research Focus: Utility Operations

Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR

WRRF-13-12

**Objectives:**

- Evaluate upstream wastewater treatment impacts (e.g. Biological treatment through nitrification/denitrification and other means, chemical treatment, industrial source control) on DPR source water quality and DPR process
- 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

*Proposals currently under review by Project Advisory Committee*

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•92

# Research Focus:
# Utility Operations and Training

## Development of Operation and Maintenance Plan and Training and Certification Framework for DPR Systems

WRRF-13-13

**Objectives**

- 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.
- Develop a DPR Training and Certification framework for DPR system operators

**Projected Outcomes**

- Operations and maintenance protocols will be developed for appropriate portions of collection system, secondary treatment processes, the following DPR advanced water treatment (AWT) processes:
  - MF/UF – RO – UV/$H_2O_2$ – Engineered Storage–$Cl_2$
  - $O_3$ – BAC – GAC – UV – Engineered Storage–$Cl_2$
- Training and Certification curriculum will developed along with recommended DPR system staffing

***Proposals currently under review by Project Advisory Committee***

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•93

# Research Focus:
# Blending Requirements

## Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Collaboration with the Water Research Foundation (RFP #4536)

**Objectives:**

This project will develop requirements and guidelines for integrating water from direct potable reuse (DPR) treatment facilities with existing water supplies to meet water quality and operational performance goals.

***Proposals have been submitted and an award is expected to be finalized in March***

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•94

# Research Focus:
# DPR Product Water Safety

Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities

Collaboration with the Water Research Foundation (RFP #4508)

**Objectives:**

- Identify key criteria by which water providers and regulators would assess the safety of direct potable reuse (DPR) product water
- Evaluate known techniques/methodologies for the assessment of DPR water safety using the identified criteria
- Evaluate the effectiveness of DPR treatment trains for the production of DPR water using the developed techniques
- Compare benchmarks to other water sources and bottled water

***Proposals have been submitted and an award is expected to be finalized in March***

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•95

# Research Focus: Economics of DPR

Develop Methodology of Comprehensive (Fiscal/Triple Bottom Line) Analysis of Alternative Water Supply Projects Compared to DPR

WRRF-14-03

**Objectives**

- 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.

**Projected Outcomes**

- A user-friendly assessment tool that can be used to compare DPR and non-DPR water supply options
- Assigned values (monetary or non-monetary) for the various TBL components that can be used in the comparisons based on Case Studies (and industry standards
- Demonstrated applicability of the assessment methodology for a range of alternative water supplies in California

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•96

# Research Focus: Community Concerns

- Identify and clarify health and safety concerns related to DPR
- Identify concerns about reliability (What happens if something goes wrong?)
- Develop communication tools to address emotional and intellectual concerns
- Develop a public outreach framework and messages that can be adapted by utilities for a variety of community audiences.

•97

# Research Focus: Community Concerns

## Demonstrating the Benefits of Engineered DPR Versus *de facto* Reuse Systems

WRRF-11-05 Glen Boyd, The Cadmus Group

**Objective**: To obtain a more quantitative assessment of the water quality impacts associated with unintentional indirect potable reuse and demonstrate how more fully engineered approaches to direct potable reuse will result in water quality benefits

**Findings**

- An increasing awareness of *de facto* reuse may help change the public perception of DPR as a regular practice for augmenting public water supplies.
- Engineered potable reuse systems produce finished water quality that is much more consistent than what is received at the influent of a surface water treatment plant from a natural water body.
- Effective outreach is proactive, rather than reactive and focuses on the benefits of the reuse project to the community and the environment

•98

# Research Focus:
# Community Concerns

Guidelines for Engineered Storage Systems
WRRF-12-06

Research Goals

1) To explore if messaging about water supply delivery mechanisms influence attitudes

2) To better understand what is most important – the safety of the water or history of the water?

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•99

# Research Focus:
# Community Concerns

Model Public Communication Plan for Advancing DPR Acceptance
WRRF-13-02 Mark Millan, Data Instincts

**Three Phases for Gaining Public Acceptance:**

I - Develop Strategic Communication Plans

II - Develop Messaging Material and Methods

III - Implement, Evaluate and Refine Plan

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•100

# Research Focus:
# Community Concerns

## Model Public Communication Plan for Advancing DPR Acceptance

WRRF-13-02 Mark Millan, Data Instincts


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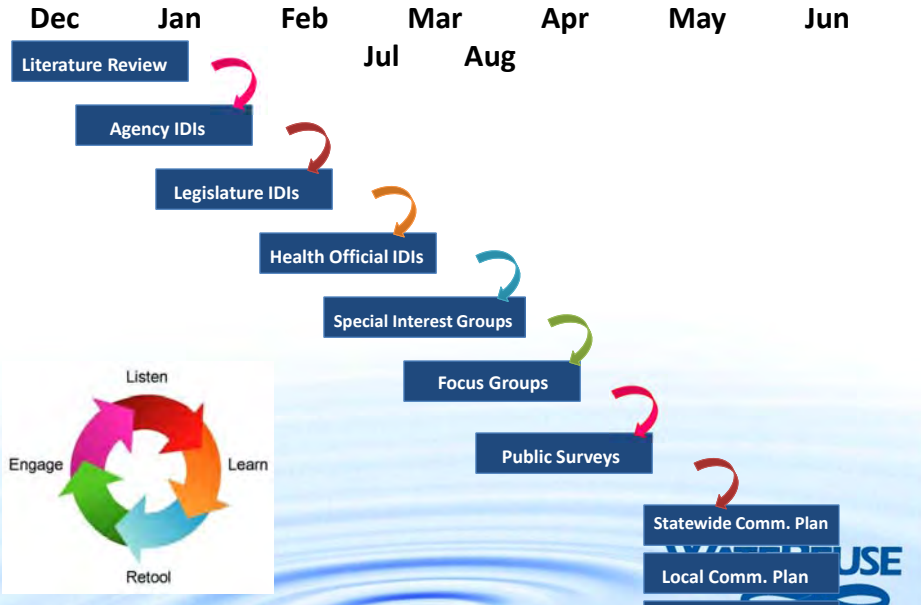

# Research Focus: Community Concerns

## DPR Rapid Response Messages

WRRF-14-04

This project will create a repository of template responses that include clear, concise, simple messages to use when responding to a range of scenarios including, but not limited to:

- Misinformation campaigns within the community
- Science debate regarding efficacy of treatment process and safety
- Broad-based illness in a community that gets water supply from a DPR plant – unspecified reason, but media is pointing to the reuse plant
- Plant under construction or operational and now it is raining – why support for potable reuse is still needed

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# Is our Current Research addressing the Regulatory, Utility, and Community Barriers/Concerns?

# What are the gaps to be further studied?

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# Research Focus: Regulatory Concerns – Treatment & Process Reliability

Reliability

- ***Develop concepts that draw upon the existing regulatory framework for drinking water to establish the definition of reliability in potable reuse***
- *WRRF-11-02, 14-02: Define treatment requirements for chemicals and pathogens of health significance*
- *11-01, 14-01: Develop on-line monitoring strategies for each unit process and demonstrate application*

Redundancy

- *11-02, 11-10, 13-03: Define the benefits of the multi-barrier concept to ensure public health protection*
- *13-03 : Describe the balance between redundancy, monitoring, and storage, and how they work together to ensure reliability*
- *11-10, 13-03: Define what level of redundant (supernumerary) treatment is necessary to ensure reliability, particularly for CDPH Path 2*
- *12-06: Design of Engineered Buffers*

Robustness

- *13-12: Develop guidelines for an acceptable DPR source water*
- *11-02, 14-05: Determine robust treatment schemes that are best suited to address unknown challenges*
- *14-05: Develop strategy to determine how to quantify the sense of the unknown with CECs*

Resilience

- *11-10, 13-03: Determine appropriate resilient strategies to ensure reliability in extreme events*

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•105

# Research Focus: Utility Concerns

**Economic and Technical**

- *WRRF-14-03: Identify methods to reduce the cost (and energy intensity) of DPR treatment*
- *11-10, 14-02 : Identify alternative treatment trains that meet public health criteria*
- ***Identify non-RO DPR treatment options to eliminate need for brine disposal***
- *13-13: Develop DPR training and operational plans*
- *WRF4508: Product water aesthetics: taste and odor*

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•106

# Research Focus: Community Concerns

**WRRF-13-02:**

- Identify and clarify health and safety concerns related DPR
- Identify concerns about reliability (What happens if something goes wrong?)
- Develop communication tools to address emotional and intellectual concerns
- Develop a public outreach framework and messages that can be adapted by utilities for a variety of community audiences.

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# Potential Future Research Identified by RAC

| Future Research Project Title | Source | Budget |
|---|---|---|
| Evaluation of Policies Integrating DPR and other Reuse Strategies into Comprehensive Water | 2014 RAC B list | $200,000 |
| Project to support CA DPR Initiative Effort document 'process', concerns, etc as learning | 2014 RAC B list | $50,000 |
| White Paper: State of the Science Report on Antibiotic Resistance in potable reuse | 2014 RAC B list | $25,000 |

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# Potential Future Research Identified by Current PIs

| Future Research Project Title | Source | Budget |
|---|---|---|
| WRRF-11-01 *Monitoring for Reliability and Process Control of Potable Reuse Applications Expansion* : Real-time Detection of Viruses in Water | Extension of current project | $60,600 |
| WRRF-11-01 *Monitoring for Reliability and Process Control of Potable Reuse Applications Expansion* : Real-time Detection of Fluorescence | Extension of current project | $98,475 |
| WRRF-11-02 *Equivalency of Advanced Treatment Trains for Potable Reuse Expansion* : Additional in vitro bioassay suite | Extension of current project | $200,000 |
| WRRF-12-06 *Guidelines for Engineered Storage Systems Expansion* : Performing real-time emergency response to treatment process or water quality failures | Extension of current project | $40,000 |

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# Potential Future Research Identified by DPR Workshop

| Future Research Project Title | Source | Budget |
|---|---|---|
| Performance Testing of the Colorado Municipal Water District's Raw Water Production Facility in Big Spring, TX | Proposed to 2014 TC program, TBD | $80,000 |
| Dealing with reverse osmosis brine in applications with non-ocean discharge | 12/12/12 DPR Workshop (DPR-OP-12-01) | TBD |
| Reducing Energy Intensity of Advanced Treatment Methods for Recycling Water | 12/12/12 DPR Workshop (DPR-TT-12-01) | $1,000,000 |
| Establishment of QA Requirements for Alternative DPR Treatment Schemes | 12/12/12 DPR Workshop (DPR-QA-12-03) | $300,000 - $350,0000 |
| Evaluate the Feasibility of Using Odor compounds as surrogates for monitoring low molecular weight particles that may pass through MF & RO and Using Flavor Profile Analysis (FPA)as part of this feasibility analysis. | 12/12/12 DPR Workshop (DPR-QA-12-01 ) | TBD |

WATEREUSE RESEARCH

Questions, Comments, Ideas for Future Research?




# Discussion: DPR Research

**11:30 am to 12:00 noon**

# Closed Panel Discussion

# ITEM 2:

# CALIFORNIA DIRECT POTABLE REUSE INITIATIVE RESEARCH PLAN

# CALIFORNIA DIRECT POTABLE REUSE INITIATIVE RESEARCH PLAN

February 25, 2014

Prepared by:

WateReuse Research Foundation

WateReuse California

## Section 1: Background, Drivers, and Participants of the DPR Initiative

### *Goal of DPR Initiative*

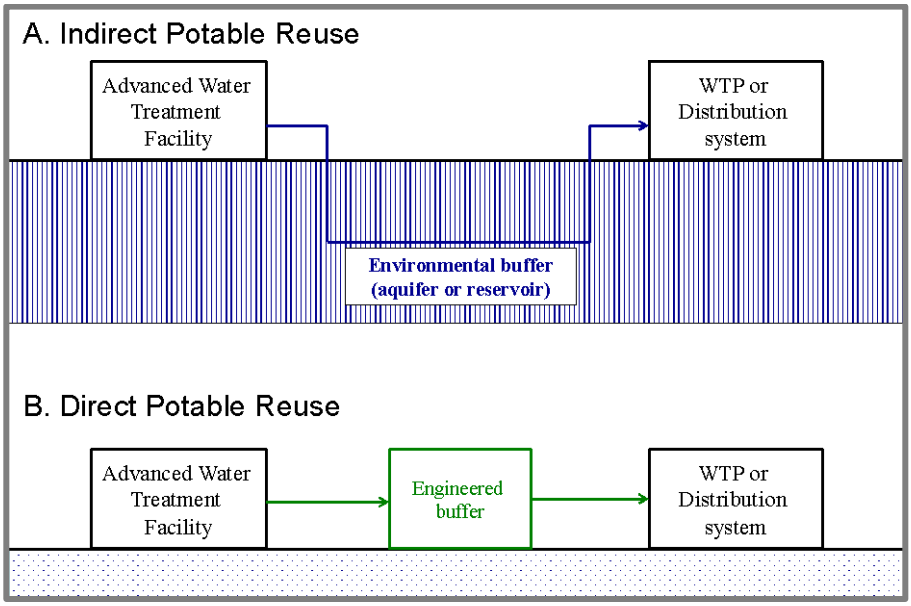
The WateReuse Research Foundation (WRRF) and WateReuse California (WRCA) have launched the CA Direct Potable Reuse (DPR) Initiative to establish DPR as a water supply option that is protective of public health and can be regulated by state agencies, can be implemented by water utilities in a safe and cost-effective manner, and is acceptable to the public.

### *Purpose of Research Plan*

The purpose of this document is to guide the research of the DPR Initiative so that it can provide information for regulators, utilities, and communities as they consider the implementation of potable reuse in the State of California. The plan can be used as a model nationally and internationally for regions considering DPR.

### *What is DPR?*

DPR is the introduction of highly treated reclaimed water *directly* into the raw water supply immediately upstream of a water treatment plant, or into the distribution system downstream of a water treatment plant. To date, proposals have been to introduce DPR water into a water treatment plant intake rather than into the distribution system. While identical in many aspects to indirect potable reuse (IPR) with full advanced treatment, DPR eliminates the passage of the treated water through an environmental buffer—such as a groundwater aquifer or a reservoir (*below*). The direct passage of treated water to the drinking water system is the main characteristic distinguishing it from the indirect path of IPR.




Despite the similarities between the two systems, DPR presents significant new benefits and challenges. By eliminating the environmental buffer, DPR can significantly reduce the energy

and cost requirements, maintain the high water quality of the advanced treated water, and remove the need for a suitable aquifer or reservoir, which are not available in all locations. Eliminating the buffer also poses important new challenges. DPR loses the benefits from the environmental buffer, namely (1) decreased contaminant removal, (2) decreased blending and dilution, and (3) shortened time period to detect and respond to treatment failures. Determining how to design and operate DPR systems to overcome these challenges represents an important technical and regulatory hurdle. The public health risks from DPR may differ from IPR, and the system must adapt to meet these differences. Beyond health considerations, DPR must also be cost-effective and acceptable to the public, the ultimate consumers of DPR.

These issues become more complex when considering the fact that DPR also exists in various forms. DPR product water can either be added to the influent of a drinking water treatment plant or pumped directly into a treated water distribution system. Given that these two scenarios provide different levels of treatment, the requirements for different DPR configurations should also be appropriately adjusted.

For DPR to move forward, research must address the needs of the three main groups of stakeholders: (1) regulators, (2) utilities, and (3) communities. Each group (and its consultants) has its own set of issues, though significant overlap exists between the groups. For regulators, the key concern is ensuring that DPR regulations are protective of public health. In their presentations, the California Department of Public Health (CDPH) has discussed two paths to achieving safe DPR systems. In Path 1, they discuss the use of (1) multiple barriers to minimize the chance of a complete treatment failure and (2) infallible treatment verification monitoring. In Path 2, they discuss the use of redundant barriers to provide supernumerary (i.e., above the minimum) log reduction capacity to compensate for any lack of reliability in the treatment, monitoring, or failure response component of the scheme so that the risk of inadequate treatment is miniscule. In both cases, the end goal is the same—a reliable DPR system, i.e., one that protects public health. Reliability is therefore the key concept for regulators.

Of the three groups, the utilities need to address the broadest range of concerns for DPR. Not only are they beholden to regulatory requirements, but they must ensure that DPR can be accomplished in a cost-effective manner while also being acceptable to the communities that they serve. Research needs for the utilities therefore spans regulatory issues, economics, and public acceptance.

Finally, the consumers of DPR water—the communities—must also be involved for the success of DPR. Communities are aware of the wastewater origin of DPR water, and are rightfully concerned about safety. Research is also needed therefore to understand what obstacles communities face in accepting DPR as a new drinking water resource.

## *Drivers for California DPR Initiative*

The California DPR Initiative was developed to address the obstacles to DPR and to move it forward as a viable means to expand our water supply. The Initiative sees that DPR has the potential to provide a sustainable and cost-competitive water supply option that is less energy-intensive than many alternative options. This new path forward is very timely given the decline in traditional water supply sources along with growing demand.

Another main driver for DPR is legislative action. The State of California's Recycled Water Policy established aggressive goals to increase recycled water production in order to help meet the State's overall water supply goal (by 2020, increase recycled water use by 1 million acre-feet per year over 2002 levels). Initially, the main tool to achieve this goal was the expansion of non-potable reuse, though it has become clear that the goal cannot be met through non-potable reuse alone. IPR has also provided a new opportunity for achieving this goal, though IPR itself has limitations that preclude its use in certain situations. Many communities without suitable groundwater aquifers or reservoirs, communities who have maximized their non-potable options, and communities that have exhausted all other water supply options could benefit from DPR.

The most significant legislation pushing DPR forward has been SB 918. In addition to advancing regulations for IPR, SB 918 also requires the State to evaluate the feasibility of DPR by the end of 2016. The California DPR Initiative aims to contribute to this movement by providing information for regulators, utilities and communities as they consider the implementation of potable reuse in the State of California.

The Initiative has identified seven strategies to achieve this goal:

1. Define the agenda for needed DPR research
2. Raise funds to support the research program
3. Commission DPR research studies
4. Use research findings to develop communication, education, and awareness programs
5. Recruit partners to disseminate the message and coalesce DPR support
6. Develop and education and outreach agenda and programs for key stakeholders
7. Establish practice and technical recommendations for utilities to adapt and adopt DPR

The focus of this document is on the first of the seven strategies: defining the agenda for DPR research. The following sections provide a framework for meeting the research needs of the three main DPR stakeholders: regulators, utilities, and communities.

## *Key Participants in DPR Initiative*

The WRRF and WRCA launched the California DPR Initiative in 2012 to provide leadership and direction in the field of DPR, a practical solution to water scarcity and water stewardship. The Initiative strives to provide needed information through both research and education & outreach.

### WRRF – Research

The research side of the initiative is led by WRRF, whose mission is to conduct and promote applied research on the reclamation, recycling, reuse, and desalination of water. The Research Foundation is an educational, nonprofit public benefit 501(c)(3) corporation that conducts applied research on behalf of the water and wastewater community for the purpose of advancing the science of water reuse, recycling, reclamation, and desalination. The Foundation's research covers a broad spectrum of issues, including chemical contaminants, microbiological agents, treatment technologies, salinity management, public perception, economics and marketing. The Foundation's research supports communities across the United States and abroad in their efforts to create new sources of high quality water while protecting public health and the environment.

In the context of the DPR Initiative, the main goal of WRRF is to support the Panel's evaluation of DPR feasibility per SB 918, and to support possible future draft regulations as appropriate.

The selection and management of research projects, including those in the DPR program, in addition to the organization of the Foundation, are described in detail in the Foundation's Operating Plan (http://www.watereuse.org/sites/default/files/u8/Operating_Plan_2010.pdf). In summary, research projects are determined on an annual basis by the Research Advisory Committee (RAC) and are approved by the Board of Directors. The RAC, comprised of 32 technical experts from around the world, meets in the beginning of each year to select and/or develop proposed research projects that reflect priority issues from the Foundation's research agenda. The RAC reviews a summary, completed by staff, of the collected information to date from research needs workshops (e.g. DPR workshop 12/12/12), Subscriber surveys/workshops, the Board, and other sources including the RAC members themselves. A list of priority projects for funding consideration under the Solicited Research Program is created and presented for approval by the Board.

Once approved, an assigned Project Manager (PM) forms a Project Advisory Committee (PAC) of 4-6 technical experts representing water and wastewater utilities, government agencies, consulting firms, etc. PACs are volunteers that provide expert peer review and technical oversight on Foundation research projects. The PM and PAC use the project description approved by the Board to develop a Request for Proposal (RFP). RFPs are posted for competitive bid on the Foundation's website and are promoted through news releases and by the WateReuse Association. PACs review proposals and come to a consensus recommendation for the project award. If there are any shortcomings of the selected proposal, award conditions are provided that the selected contractor must address in a revised scope of work.

Once a funding agreement is negotiated between The Foundation and the project team, the project commences. Quarterly progress reports are submitted to the Foundation and reviewed by the PAC to ensure the project progresses as expected. The contractor is responsible for addressing any of the PACs concerns during the project. The research team, PAC, and PM typically meet in person at least once during the project for a workshop, kickoff meeting, or at the end of the project to discuss project scope and conclusions. At the end of the project, the team submits a final report in addition to any other deliverables as stated in the RFP, which goes through several reviews prior to publication.

**WRCA – Education and Outreach**

Education and outreach activities are led by WRCA. The purpose of these activities is to provide information about DPR to support decision-making by stakeholders at State, regional and local level, and to develop information to support the education and outreach activities undertaken by the utilities.

## Section 2: Research Path to achieve DPR Initiative's goal

To achieve the 2016 goal of SB 918, regulatory, scientific, technical, and attitudinal barriers to DPR need to be removed and/or addressed. Overcoming these hurdles requires undertaking three main tasks:

1. Conduct rigorous scientific research
2. Communicate the research findings through public awareness programs
3. Work with regulatory authorities to facilitate DPR implementation by local water utilities

To accomplish these tasks in the most effective manner, a research framework for ensuring the integration and complementarity of these tasks is needed. This framework is meant to provide a structure for determining important research focuses and to aid in assigning research priorities. All of the research must serve the principal goal of understanding the feasibility of the future of DPR in California. Given the varying needs of the main stakeholders, the research framework needs to be broad enough to cover the concerns of each group, while maintaining a global vision that allows the groups to achieve their shared goals.

### *Research Framework 1: Regulatory Concerns*

To address the regulatory concerns, the research framework should focus on the ultimate goal of DPR systems – the provision of a safe and reliable potable supply. As stated above, **reliability** in the DPR setting is defined as the provision of a potable supply that is protective of public health at all times. To achieve reliability, a number of supporting concepts can be used including **redundancy**, **robustness**, and **resilience**. The DPR process (including source control, treatment, monitoring, operations, training, maintenance, etc.) can achieve reliability by incorporating these three factors into system design and operation. A reliable DPR process incorporates **r**edundancy (i.e., the use of multiple barriers to control acute risks) and **r**obustness (i.e., capacity to remove a wide range of contaminants) to control microbial and chemical risks under typical operation scenarios. In addition, DPR facilities must also be **r**esilient to ensure reliability even during rare failure events. A resilient system is not a system that never fails, but a system that fails safely, meaning that it responds to failure by preventing the distribution (and consumption) of all water that does not meet requirements. In ensuring the provision of safe DPR water, redundancy, robustness, and resilience all contribute to reliability.

The research plan can support the regulatory aspects of DPR by focusing on the reliability framework. Examples of specific research products that could be important guideposts toward this are raised in the following bullet points. It should be emphasized that this list of research products is not exhaustive.

<u>Reliability</u>

- *Develop concepts that draw upon the existing regulatory framework for drinking water to establish the definition of reliability in potable reuse*
- *Define treatment requirements for chemicals and pathogens of health significance*

- *Develop on-line monitoring strategies for each unit process and demonstrate application*

Redundancy

- *Define the benefits of the multi-barrier concept to ensure public health protection*
- *Describe the balance between redundancy, monitoring, and storage, and how they work together to ensure reliability*
- *Define what level of redundant (supernumerary) treatment is necessary to ensure reliability, particularly for CDPH Path 2*

Robustness

- *Develop guidelines for an acceptable DPR source water*
- *Determine robust treatment schemes that are best suited to address unknown challenges*
- *Develop strategy to determine how to quantify the sense of the unknown with CECs*

Resilience

- *Determine appropriate resilient strategies to ensure reliability in extreme events*

## *Research Framework 2: Utility Concerns*

The research needed to address utility concerns is the broadest of the three stakeholder groups, given their interaction with both regulatory issues (Framework 1) and community issues (Framework 3). Utilities also have a number of unique research needs that are specific to their issues, mainly focusing on the economic and technical feasibility of DPR systems. Research Framework 2 therefore focuses on overcoming the specific **technical** and **economic** obstacles that currently affect DPR implementation.

Examples of specific research products that could be important guideposts toward this are raised in the following bullet points. It should be emphasized that this list of research products is not exhaustive.

Economic and Technical

- *Identify methods to reduce the cost (and energy intensity) of DPR treatment*
- *Identify alternative treatment trains that meet public health criteria*
- *Identify non-RO DPR treatment options to eliminate need for brine disposal*
- *Develop DPR training and operational plans*

## *Research Framework 3: Community Concerns*

Addressing community concerns represents a significant challenge in achieving the goal of widespread public acceptance for DPR. Research is needed to explore and assess the critical concerns among community members and survey attitudes about DPR. Activities would include gauging the general understanding of DPR, identifying the primary concerns, and developing educational and communication tools that support acceptance. Learning how members of the community respond to the idea of DPR — emotionally and objectively — and focusing in on their main concerns are key pieces in understanding public perception and developing the tools and messages that will support acceptance.

The emphasis of Research Framework 3 should be Awareness, Education and Acceptance. Research in this area would include various assessment, in-depth interviews, surveying, focus groups, and communication research (message testing and evaluation). The areas of research could include:

- Identify and clarify health and safety concerns related DPR
- Identify concerns about reliability (What happens if something goes wrong?)
- Develop communication tools to address emotional and intellectual concerns
- Develop a public outreach framework and messages that can be adapted by utilities for a variety of community audiences.

## Section 3: Current WateReuse Research Foundation DPR Research Projects

In 2011, WRRF began its program specifically geared towards DPR with funding research identified by WateReuse's *Direct Potable Reuse: A Path Forward*, the 2012 NRC report on potable reuse, and the investors of the California DPR Initiative. These six projects (WRRF-11-01, 11-02, 11-05, 11-10, 12-06, and 12-07), representing over $3.8 million in research, created a solid foundation exploring the viability of DPR. Significant findings and conclusions will arise from these initial DPR projects and will help steer future DPR research.

In the meantime, WRRF and WRCA hosted a DPR Research Needs Workshop at West Basin's Edward C. Little Water Recycling Facility in December 2012 to identify research gaps to be addressed in new research. Attended by more than 50 (Appendix A) international leaders in potable reuse, the workshop divided the experts in industry, academics, consulting, and regulators into four strategic breakout groups (Operations, Quality Assurance, Treatment Technology, and Public Acceptance). Descriptions for 22 projects resulted and were ranked by the workshop attendees.

This ranked list was submitted to the Foundation's Research Advisory Committee (RAC) for review and selection at their January 2013 meeting. The RAC further developed four projects addressing regulatory, utility, and community concerns. This 2013 DPR research approved by the Board (WRRF-13-02, 13-03, 13-12, 13-13) totals $1,000,000 and is funded by the CA DPR Initiative donors as well as Metropolitan Water District of Southern California. This program is further enhanced by collaboration with the Water Research Foundation (WaterRF), who is funding and managing an additional two projects at $600,000.

The RAC again met in January 2014 and added more important research to address remaining gaps in DPR. The RAC built off of existing projects and recommended research to develop six new projects to be started in 2014 (pending Board approval in March). Those 2014 projects add another $1.15 million to the DPR program to address technical and public acceptance concerns with DPR.

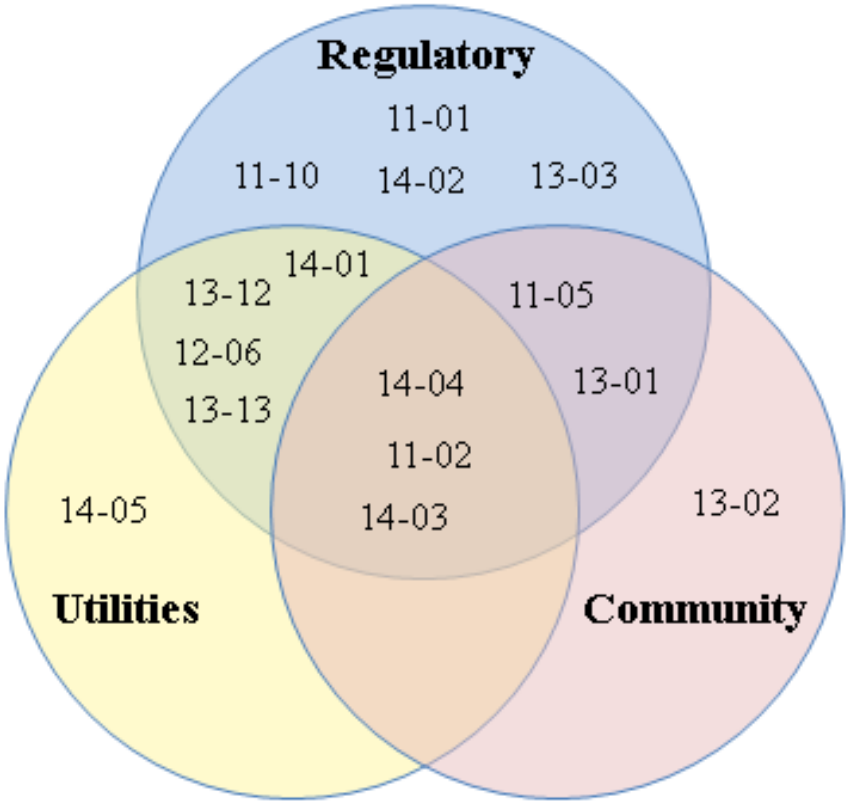
The Foundation's 17 DPR projects initiated in 2014 or before total over $7.2 million in research to evaluate and demonstrate the feasibility of DPR (Table 1). A detailed description of the current DPR research portfolio is presented in Appendix B.

Table 1. WRRF DPR Research Program 2011 - 2014

| Project # | Research Project Title | Principal Investigator | Expected | WRRF contribution | In Kind Contribution |
|---|---|---|---|---|---|
| WRRF-11-01 | Monitoring for Reliability and Process Control of Potable Reuse Applications | Ian Pepper, University of Arizona | Dec-15 | $400,000 | $1,298,817 |
| WRRF-11-02 | Equivalency of Advanced Treatment Trains for Potable Reuse | Rhodes Trussell, Trussell Technologies | Jul-15 | $375,000 | $868,000 |
| WRRF-11-05 | Demonstrating the Benefits of Engineered Direct Potable Reuse versus Unintentional Indirect Potable Reuse Systems | Glen Boyd, The Cadmus Ground Inc | May-14 | $49,558 | $10,000 |
| WRRF-11-10 | Evaluation of Risk Reduction Principles for Direct Potable Reuse | Andy Salveson, Carollo Engineers | Jun-14 | $73,407 | $71,555 |
| WRRF-12-06 | Guidelines for Engineered Storage for Direct Potable Reuse | Andy Salveson, Carollo Engineers | Jun-14 | $100,000 | $111,788 |
| WRRF-12-07 | Methods for Integrity Testing of NF and RO Membranes | Joe Jacangelo, MWH | Feb-16 | $300,000 | $296,965 |
| WRRF-13-02 | Model Public Communication Plan for Advancing DPR Acceptance | Mark Millan, Data Instincts; Patsy Tennyson, Katz & Associates | Feb-14 | $300,000 | $272,606 |
| WRRF-13-03 | Critical Control Point assessment to quantify robustness and reliability of multiple treatment barriers of DPR scheme | Troy Walker, Hazen & Sawyer | Feb-16 | $337,125 | $238,969 |
| WRRF-13-12 | Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR | TBD | Feb-16 | $150,000 | TBD |
| WRRF-13-13 | Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse (DPR) Systems | TBD | Feb-16 | $250,000 | TBD |
| WRRF-13-15 (WRF4536) | Blending Requirements for Water from Direct Potable Reuse Treatment Facilities | TBD in March (managed by WRF) | TBD | $325,000 | TBD |
| WRRF-13-14 (WRF4508) | Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities | TBD in March (managed by WRF) | TBD | $275,000 | TBD |
| WRRF-14-01 | Integrated Management of Sensor Data for Real Time Decision Making and Response | TBD | TBD | $300,000 | TBD |
| WRRF-14-02 | Establishing additional log reduction credits for WWTPs | TBD | TBD | $400,000 | TBD |
| WRRF-14-03 | Develop Methology of comprehensive (fiscal/triple bottom line) analysis of alternative water supply projects compared to DPR | TBD | TBD | $250,000 | TBD |
| WRRF-14-04 | DPR Rapid Response Messages | TBD | TBD | $150,000 | TBD |
| WRRF-14-05 | Screening high risk chemicals potential of passage through RO/AOP | TBD | TBD | $100,000 | TBD |

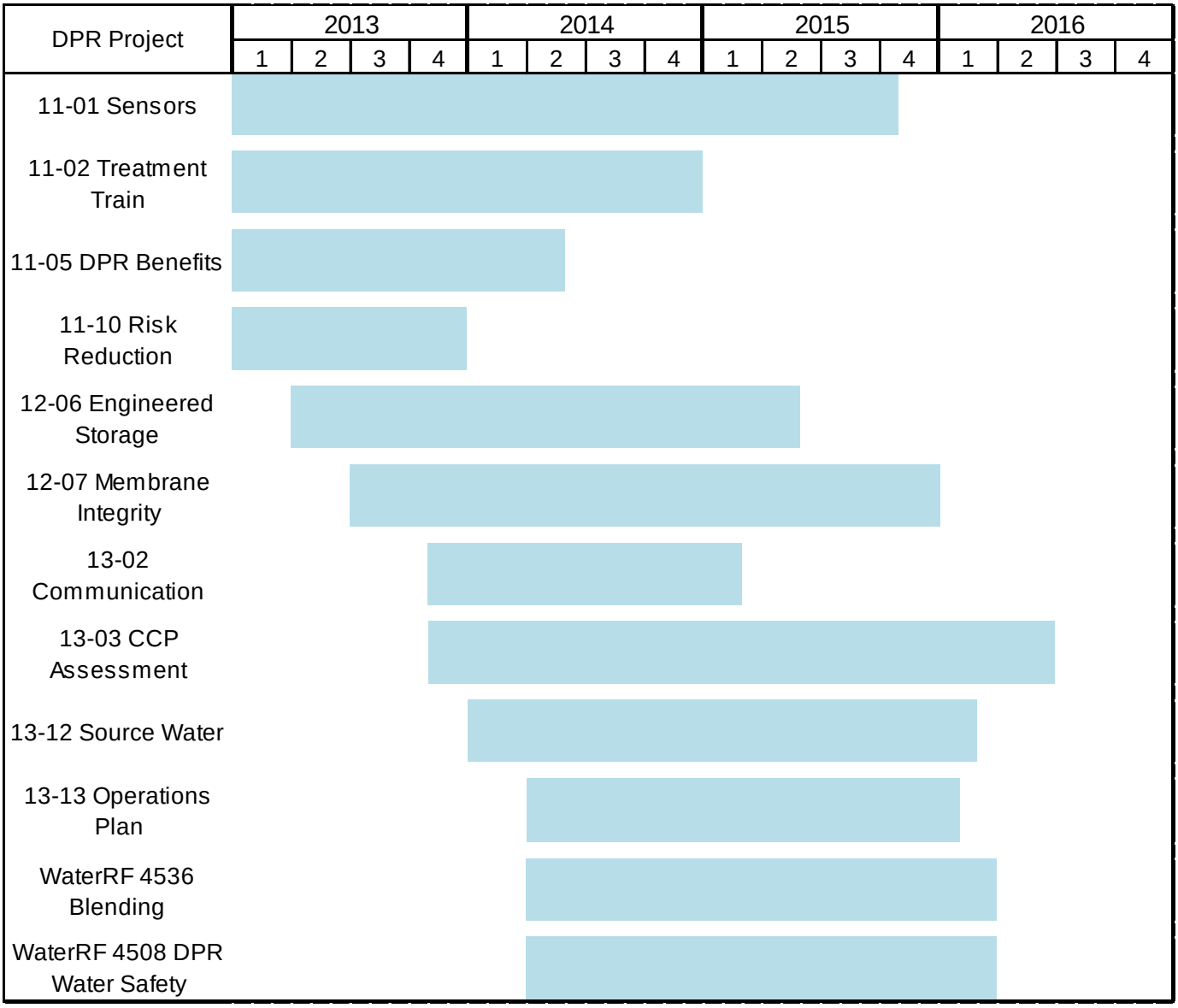
The DPR research projects in Table 1 are identified into the three main research focuses, displayed graphically in the Venn diagram in Figure 2. All of this DPR research is highly complementary of each other and must be closely coordinated to share approach and results throughout the duration of the project work. WRRF coordinates biannual meetings with the project teams of these DPR projects to encourage communication and avoid duplication.

**Figure 2. Venn Diagram of Reliability Framework**



As displayed in Figure 3, the 12 DPR projects that are underway are due for completion between the end of 2013 and 2016. The 2014 DPR projects will be added to the timeline once duration is provided by the awarded research teams in late 2014.

**Figure 3: Current DPR Research Timelines**



## Section 4: Future Research and Next Steps

New DPR research will be initiated in 2015 and beyond to ensure gaps are filled to illustrate the feasibility of DPR. Several sources will be considered for this new research. After funding six projects in 2013 and incorporating/combining descriptions, nine out of the original 22 research projects proposed at the 12/12/12 DPR Workshop remain (Table 2). These will be candidate projects for the RAC in their annual consideration of research to fund. Additionally, the recommendations of the current 11 projects underway will come into clearer focus and will be considered. To take advantage of the evolving knowledge, future DPR Research Needs (through survey, panels, workshops, etc) will be considered to assess progress and redirect research priorities towards promising paths.

**Table 2. Remaining (unfunded) DPR Projects**

| Future Research Project Title | Source | Budget |
|---|---|---|
| Evaluation of Policies Integrating DPR and other Reuse Strategies into Comprehensive Water Supply Planning | 2014 RAC B list | $200,000 |
| Project to support CA DPR Initiative Effort document 'process', concerns, etc as learning document | 2014 RAC B list | $50,000 |
| White Paper: State of the Science Report on Antibiotic Resistance in potable reuse applications | 2014 RAC B list | $25,000 |
| WRRF-11-01 *Monitoring for Reliability and Process Control of Potable Reuse Applications Expansion*: Real-time Detection of Viruses in Water | Extension of current project | $60,600 |
| WRRF-11-01 *Monitoring for Reliability and Process Control of Potable Reuse Applications Expansion*: Real-time Detection of Fluorescence | Extension of current project | $98,475 |
| WRRF-11-02 *Equivalency of Advanced Treatment Trains for Potable Reuse Expansion*: Additional in vitro bioassay suite | Extension of current project | $200,000 |
| WRRF-12-06 *Guidelines for Engineered Storage Systems Expansion*: Performing real-time emergency response to treatment process or water quality failures | Extension of current project | $40,000 |
| Performance Testing of the Colorado Municipal Water District's Raw Water Production Facility in Big Spring, TX | proposed to 2014 TC program, TBD | $80,000 |
| Dealing with reverse osmosis brine in applications with non-ocean discharge | 12/12/12 DPR Workshop (DPR-OP-12-01) | TBD |
| Reducing Energy Intensity of Advanced Treatment Methods for Recycling Water | 12/12/12 DPR Workshop (DPR-TT-12-01) | $1,000,000 |
| Establishment of QA Requirements for Alternative DPR Treatment Schemes | 12/12/12 DPR Workshop (DPR-QA-12-03) | $300,000 - $350,0000 |

| | | |
|---|---|---|
| Evaluate the Feasibility of Using Odor compounds as surrogates for monitoring low molecular weight particles that may pass through MF & RO and Using Flavor Profile Analysis (FPA)as part of this feasibility analysis. | 12/12/12 DPR Workshop (DPR-QA-12-01 ) | TBD |

## Appendix A: Attendees of 12/12/12 DPR Workshop held at West Basin Municipal Water District

| Last Name | First Name | Affliation |
|---|---|---|
| Bardowell | Phylyp | Office of Congresswoman Napolitano |
| Barnard | Randy | CA Department of Public Health |
| Bernados | Brian | CA Department of Public Health |
| Bishop | Jonathan | SWRCB |
| Brown | Garry | Orange County Coastkeeper |
| Bunts | Don | Santa Margarita Water District |
| Campos | Carlos | Suez Environment |
| Cline | Shonnie | Water Research Foundation |
| Cook | Paul | Irvine Ranch Water District |
| Cotruvo | Joseph | Joseph Cotruvo & Associates, LLC |
| Crozes | Gil | Carollo |
| Drewes | Jorg | Colorado School of Mines |
| Festger | Adam | Trojan Technologies |
| Fiedler | Jim | Santa Clara Valley Water District |
| Ghirelli | Bob | Orange County Sanitation District |
| Haddad | Brent | University of California, Santa Cruz |
| Hultquist | Robert | CA Department of Public Health |
| Infurnari | Mike | WateReuse Research Foundation |
| Jacangelo | Joe | MWH |
| Jones | Paul | Eastern Municipal Water District |
| LeChevallier | Mark | American Water |
| Lovell | Adam | Water Services Association of Australia |
| Macpherson | Linda | CH2M Hill |
| McDonald | Ellen | Alan Plummer & Associates |
| Millan | Mark | Data Instincts, Public Outreach Consultants |
| Miller | Wade | WateReuse Association |
| Minton | Julie | WateReuse Research Foundation |
| Mosher | Jeff | National Water Research Institute |
| Nagel | Richard | West Basin Municipal Water District |
| Nellor | Margie | Nellor Environmental Associates, Inc. |
| Owen | Doug | Malclm Pirnie, ARCADIS |
| Pettijohn | Dave | LADWP |
| Price | Kevin | USBR |
| Provencher | Lisette | United Water |
| Rayburn | Chris | Water Research Foundation |
| Richardson | Tom | RMC Water and Environment |
| Rossi | John | Western Municiapal Water District |

| | | |
|---|---|---|
| Ruiz | Hector | Trabuco Canyon Water District |
| Salveson | Andrew | Carollo |
| Smith | David | WateReuse California |
| Snyder | Shane | University of Arizona |
| Spivy-Weber | Fran | California State Water Resources Control Board |
| Steele | Bill | USBR |
| Trejo | Reymundo | Upper San Gabriel Valley MWD |
| Tremblay | Ray | Los Angeles County Sanitation District |
| Trussell | Rhodes | Trussell Technologies |
| Trussell | Shane | Trussell Technologies |
| Wehner | Michael | Orange County Water District |
| Whitaker | Robb | Water Replenishment District of Southern CA |
| Wildermuth | Ron | West Basin Municipal Water District |
| Yamamoto | Gary | CA Department of  Public Health |
| Zornes | Greta | ConocoPhillips |

# Appendix B. DPR Research Project Details

**1. WRRF-11-01, *Monitoring for Reliability and Process Control of Potable Reuse Applications* (Contractor: University of Arizona)**

The objective of this project is to identify, evaluate, test, and validate monitoring systems that can be used to assure the public safety of potable reuse. The project is specifically focused on real-time or near real-time monitoring for the removal of trace organics and biological contaminants.

The project is comprised of three tasks: 1) state of knowledge and initial workshop, 2) laboratory evaluation of monitoring control systems and 3) pilot and full-scale evaluations.

Status: The project is on track; the team submitted their sixth progress report in January 2014 and will be submitting their seventh progress report in March 2014.

Notable Update:

Task 2 is is currently 85% complete. The purpose of this task is to identify correlations between treatment performance and sensor response. As part of this task the following will be performed:

- Treatment train development: The following treatment trains will be evaluated at the lab-scale. The treatment trains were selected in consistence with project WateReuse11-02.

  *From secondary treatment → MF/UF → RO → UV/AOP → To reuse application*

  *From secondary/ tertiary treatment* → *MF/UF* → $O_3$ → *GAC/BAC* → *From surface/groundwater augmentation*

- Use of surrogates to predict trace organic compound (TOrc) removal by granular activated carbon: The purpose of this subtask is to develop correlations between bulk organic parameters (e.g. color, total organic carbon, UV absorbance and fluorescence excitation/emission spectroscopy) and TOrC removal during oxidation processes. Some preliminary testing has been performed. The project team is evaluating and analyzing the data.

- Data Acquisition Software Development: The purpose of this sub-task is to develop a SCADA system for monitoring and controlling the water quality throughout the treatment train for water reuse

- On-line Sensors for Real-Time Monitoring of Water Quality: As part of this sub-task, 10 different online sensors were installed in the lab and are currently being evaluated (see Table 3). These sensors are capable of measuring 13 different surrogate parameters of water quality which can be divided into four categories: i) general (pH, temperature, conductivity, turbidity); ii) organic (UVT254, UVA254, TOC, DOC,

fluorescence); iii) inorganic (chlorine, $NO_3$-N); and iv) microbial parameters (total cell count, microbial toxicity

**Table 3: Surrogate parameters and online sensors that will be analyzed as part of WateReuse-11-01 Task 2**


| General parameters | Organic parameters | Inorganic parameters | Microbial parameters |
|---|---|---|---|
| pH | UVT 254 (%) | Chlorine (mg/L) | Total cell count (counts/100mL) |
| Temperature (ºC) | UVA 254 ($cm^{-1}$) | $NO_3$-N (mg/L) | Toxicity (%) |
| Conductivity (µS/cm) | DOC (mg/L) | | |
| Turbidity (NTU) | TOC (mg/L) | | |
| | Fluorescence (A.U.) | | |

To date, the following has been accomplished:

- Two Reverse osmosis units built
- Development of treatment technologies for UV, O3, ± $H_2O_2$
- IQ SensorNet installed
- LabView Software system installed for data stream collection from all sensors simultaneously
- SAFire fluorescence online sensor evaluated as surrogate for dissolved organic matter
- Instant BioScan evaluated as a real-time microbial sensor
- Advanced oxidation via ozone evaluated for removal of contaminants

## 2. WateReuse-11-02, *Equivalency of Advanced Treatment Trains for Potable Reuse* (Contractor: Trussell Technologies)

This project will clearly identify the benefits and tradeoffs of various treatment process trains for potable reuse. This project will consider and examine criteria needed to evaluate the adequacy of treatment for direct and indirect potable reuse. A model will be developed that can allow for comparisons of alternate treatment trains for potable reuse. At least one advanced treatment train will be tested for direct potable reuse at a scale large enough to give information on real operating conditions.

Status: The project is on track. The National Water Research Institute (NWRI) coordinated an Independent Advisory Panel (Panel) to lead a 2-day workshop to develop a set of criteria that are protective of public health to evaluate treatment technologies for DPR. This Panel Report entitled *Examining the Criteria for Direct Potable Reuse* has been released. Shane

and Rhodes Trussell attended the DPR Collaboration Meeting on 5/6/13 in Phoenix. In addition, a two-part webcast was conducted by the project team briefing attendants on the preliminary results of this project. The team submitted their sixth progress report in November 2013 and is expected to submit their seventh in February 2014.

Notable Update:

To date, the team has completed or nearly completed all of the work comprising Task 1 and has made significant progress on Tasks 2 and 3. Within Task 1, the project team completed Task 1A (Literature Review) and Task 1B (Review of Available Public Health Criteria). The deliverable from these tasks was a Literature Review document that was distributed to the Expert Panel and the PAC prior to the September workshop. To satisfy Task 1C (Develop Criteria that are Protective of Public Health to Evaluate Treatment Technologies for Direct Potable Reuse), the project team developed a set of "Strawman" criteria—in the form of PowerPoint presentations—that were distributed to the PAC and Expert Panel prior to the workshop. Task 1C also included the August 29, 2012 workshop that was co-run with NWRI at the LA Department of Water and Power. The Expert Panel then refined these criteria in their Expert Panel Report; these treatment goals will serve as the final equivalency criteria for the evaluation of DPR treatment technologies. The PAC provided comments on the draft Expert Panel Report, and these comments were incorporated into the revised version of the Expert Panel Report that was included with a previous progress report. Finally, the project team created a State of the Science (SoS) Report for Task 1E that incorporates all of the information compiled in Task 1, including the literature review (Tasks 1A and 1B), the final set of public health criteria (Task 1C), and the additional design criteria for potable reuse trains (Task 1D). The draft SoS Report was revised based on comments from the PAC and included in a previous progress report. New science in potable reuse and proposals for new potable reuse projects are released frequently. We recommend the SoS Report be published as an independent WateReuse Research Foundation Report so that the information it contains can be timely and so that its contents can contribute to this active and dynamic dialogue.

In Task 2, the project team has completed a draft of the digital Toolbox, which includes a wide range of treatment technologies and treatment performance. Toolbox users are now able to combine a series of technologies to meet specified levels of pathogen and pollutant treatment. Two further efforts are required on this toolbox: 1) costs of treatment must be assembled, and 2) modifications to the treatment credits will be implemented once pilot testing is complete.

In conjunction with the initial findings from the Toolbox, potential treatment trains for near-full-scale direct potable reuse testing have been identified. The project team has developed a draft test protocol based on these treatment trains and the availability of pilot equipment (Task 3). Pilot testing at San Luis Obispo Water Reclamation Plant (WRP) was completed in March and follow up testing will be completed in July. Site modifications, including the installation of secondary containment to prevent runoff from potential pilot plant leaks from entering storm drains, were made at LACSD's San Jose Creek Water Reclamation Plant (SJCWRP) to accommodate pilot equipment at that location. The WEDECO ozone system, Leopold BAC pilot unit, Econity MF pilot unit, LACSD RO skid, and GE UF skid have been delivered to SJCWRP. The WEDECO and Leopold systems began operating in June, and the

Econity, GE and RO skids began operating in September. All of those pilot units are currently operating as part of Phase 1 testing.

**3. WateReuse-11-05*, Demonstrating the Benefits of Engineered Direct Potable Reuse versus Unintentional Indirect Potable Reuse Systems* (Contractor: The Cadmus Group Inc)**

This project will obtain a more quantitative assessment of the water quality impacts associated with unintentional indirect potable reuse and demonstrate how more fully engineered approaches to direct potable reuse will result in water quality benefits.

Status: The project has been completed and will be published in the Spring of 2014.

Conclusions: The findings of this study indicate that predicted concentrations at intakes were largely dependent on dilution, background concentrations of contaminants in surface water, ambient temperature, and the residence time of the contaminants in the system. However, the impacts of effluent discharges on water quality at intakes were considered negligible. The selected analytical approach was appropriate for understanding system behavior in the selected ***Unintentional Indirect Potable Reuse (de facto reuse)*** cases and allowed for a consistent comparison of water quality impacts among different systems where data were limited. This approach may be adapted by other utilities that are located only a short distance downstream from the nearest wastewater treatment discharge point, have a limited number of non-point source discharges in that distance, and have adequate data on trace organics to assess the concentrations at the water intake. However, conclusions from this study were restricted by older source water quality data, limited data on emerging contaminants of concern, and asynchronous data collection efforts by different entities.

**4. WateReuse-11-10, Evaluation of Risk Reduction Principles for Direct Potable Reuse (Contractor: Carollo Engineers)**

The goal of this project is to identify how fail-safe concepts developed in other industries (structural/bridge, aviation/NASA) can be adapted and applied to DPR systems. The resultant guidance and recommendations will be built in a stepwise fashion from the foundation of "what we know" up through "what we could do," to "the pros, cons, and costs of the identified DPR approach alternatives."

Status: Project was submitted to the publication queue for copyediting. Anticipated publication date is May 1, 2014.

Conclusions: DPR is without an environmental buffer such as a groundwater basin or a surface water reservoir. Potable reuse of highly treated reclaimed water without an environmental buffer is worthy of consideration as an alternative water supply. Understanding and replacing the value of the environmental buffer is a key component of this project. Concepts central to this work include:

- Multi-barrier treatment. Treatment is provided by multiple unit processes so that no one process is responsible for providing the full level of public health protection. The

treatment provided by each unit can be partially or completely duplicative to another process (i.e., provide redundant treatment).

- Redundant treatment. Treatment that is provided in excess of the required minimum needed to maintain adequate public health protection. This is typically provided as a back-up in case another process fails to provide adequate treatment.
- Process reliability. A measure of how consistently a treatment system can be depended upon to perform to specifications.

The project team recognizes that this project represents the beginning of DPR guidance criteria. As such, a number of recommendations for setting treatment goals for *reclaimed water as source water or as a potable source* are suggested.

In the absence of the environmental buffer, treatment processes need accurate, robust real-time, online monitoring of effluent quality. This monitoring ideally ensures process performance and alarms when process effluent quality changes. These improved monitoring techniques should be sensitive enough to pick up small changes and trends in treatment performance that could have a significant impact on the safety of the finished water. The monitoring techniques would focus on both microbes and trace pollutants.

**5. WateReuse-12-06, *Guidelines for Engineered Storage for Direct Potable Reuse Systems* (Contractor: Carollo Engineers)**

The main objective of this project is to develop recommendations for optimizing engineered storage systems for direct potable reuse; this will be accomplished through examining current practices and existing research to generate a guidance document and report.

Status: The second progress report was submitted during the quarter. The project is on schedule.

Notable Update: Project Principal Investigator and Co-PIs have submitted several abstracts to present the work at conferences including ACE, WRRF Research Conference, and Texas Water. The public outreach work was also presented by Linda MacPherson as part of an NWRI workshop on Direct Potable Reuse Public Perception on February 25.

**6. WateReuse-12-07, *Standard Methods for Integrity Testing and On-line Monitoring of NF and RO Membranes* (Contractor: MWH Global)**

The main goal is to create scientifically-based method(s) for the integrity testing of high pressure membranes, including nanofiltration (NF) and reverse osmosis (RO) membranes. Once developed, the goal is to have the methods adopted as industry standards and approved for higher pathogen removal credits by regulatory agencies.

Status: The second progress report from MWH will be submitted in the next weeks. The project team is behind with this report.

Notable Update: A project kick-off meeting was held on October 3rd, 2013 between the Foundation, project team, and PAC members. The literature review has been completed and reviewed by the PAC. A survey on NF and RO integrity monitoring utilized by water utilities, technology providers and membrane manufacturers has been sent to the project participants. The survey results will be discussed during two workshops in early 2014.

**7. WateReuse-13-02, *Model Public Communication Plan for Advancing DPR Acceptance* (Contractor: TBD)**

The objective of this project is to establish a framework communication plan and develop an implementable, strategic communication plan to achieve DPR acceptance for the State of California.

Status: The project was awarded to Data Instincts, and after negotiating the funding agreement, the project commenced on November 15, 2014.

Notable updates: The work was presented by Mark Millan as part of an NWRI workshop on Direct Potable Reuse Public Perception on February 25.

**8. WateReuse-13-03, *Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme* (Contractor: Hazen & Sawyer)**

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/$H_2O_2$ – $Cl_2$ – Engineered Storage
    b. $O_3$ – BAC – GAC – UV – $Cl_2$ – 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.

Research Approach:

1. Conduct hazard assessment for key unit operations and determine critical control points
2. Conduct bench/pilot level challenge test studies
3. Conduct Monte Carlo risk analysis and develop standard design approaches, operational procedures, and response strategies

Project Update: This project was awarded to Hazen & Sawyer in December 2013 with the project commencing shortly thereafter. The project team has assembled a multi-disciplinary

Hazard Analysis and Critical Control Points (HACCP) team to assist in the delivery of project outcomes. The first of two workshops with the HACCP team has been scheduled for February 2014 to fully vet the water quality objectives, critical control points, and final list of chemical and microbial indicators and surrogates. The first progress report is due April 2014.

9. **WateReuse-13-12*, Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR* (Contractor: TBD)**

   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.

   Project Update: The RFP was released on January 14, 2014. Four proposals were received, and they are currently being reviewed by the PAC to determine who the award will go to. This decision is expected to be made in March.

10. **WateReuse-13-13*, Operations Plan Development Standard* (Contractor TBD)**

    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.

    Project Update: The PAC has been formed. Proposals for the RFP were due February 18, 2014 and the PAC is currently reviewing three proposals. An award should be issued in late March 2014.

11. **WaterRF 4536*, Blending Requirements for Water from DPR Treatment Facilities* (Contractor: TBD; managed by Water Research Foundation)**

    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

    Water Research Foundation will manage this project, through a process similar to WateReuse.

    Project Update: The RFP has been released and an award should be announced shortly.

12. **WaterRF 4508*, Assessment of techniques for evaluating and demonstrating safety of DPR product water* (Contractor: TBD; managed by Water Research Foundation)**

    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; to perform benchmarking to other water sources (e.g. surface water, bottled water, etc.); and to develop tools and methods for utilities to demonstrate water safety to the public, elected officials, etc.

Water Research Foundation will manage this project, through a process similar to WateReuse.

Project Update: The RFP has been released and an award should be announced shortly.

**13. WRRF-14-01, Integrated Management of Sensor Data for Real Time Decision Making and Response (Contractor: TBD)**

The objectives of this project are as follows:

Develop an operation support tool that integrates diverse sensors within the treatment process for immediate feedback/alerts. Integrate existing sensors as an early warning system for a Direct Potable Reuse (DPR) treatment process to provide:

- Real time sensor network for tracking system performance and key quality parameters,
- A tool for early detection of system anomalies prior to any compromise in water quality.

Build on criteria developed in WRRF-13-03 and 13-13 for decision making based on established critical control points.

Develop framework for sensor data integration based on above criteria.

Project Update: This project was developed by the RAC in their January 2014 meeting and will be approved by the Board in late March. Once approved, a PAC will be formed and the RFP developed.

**14. WRRF-14-02, Establishing additional log reduction credits for WWTPs (Contractor: TBD)**

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.

Project Update: This project was developed by the RAC in their January 2014 meeting and will be approved by the Board in late March. Once approved, a PAC will be formed and the RFP developed.

**15. WRRF-14-03, Develop Methology 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.

Project Update: This project was developed by the RAC in their January 2014 meeting and will be approved by the Board in late March. Once approved, a PAC will be formed and the RFP developed.

**16. WRRF-14-04, DPR Rapid Response Messages (Contractor: TBD)**

The objective of this project is to ensure that messaging to members of the public, media and policy makers around DPR are consistent, accurate and readily available to water agencies.

Project Update: This project was developed by the RAC in their January 2014 meeting and will be approved by the Board in late March. Once approved, a PAC will be formed and the RFP developed.

**17. WRRF-14-05, Screening high risk chemicals potential of passage through RO/AOP (Contractor: TBD)**

The purpose of this project is to summarize the screening process aimed at identify potential for registered chemicals to pass RO-UV/H2O2 barriers in a DPR system, including identification of potential compounds (inorganic and organic) that are likely to occur, pass treatment, pose health risk or pose aesthetic risks to consumers.

- Task 1 – Identify characteristics of inorganic and organic compounds that are not rejected by RO.
- Task 2 – Develop a strategy and screen large numbers of registered inorganic and organic compounds for their ability to pass RO membranes.
- Task 3 – Develop a strategy and screen compounds that pass RO to be oxidized by UV/H2O2.
- Task 4 – Project management, reporting, and outreach

# ITEM 3:

# CALIFORNIA WATER CODE SECTION 13560-13569

# WATER CODE
# SECTION 13560-13569

13560. The Legislature finds and declares the following:

(a) In February 2009, the state board unanimously adopted, as Resolution No. 2009-0011, an updated water recycling policy, which includes the goal of increasing the use of recycled water in the state over 2002 levels by at least 1,000,000 acre-feet per year by 2020 and by at least 2,000,000 acre-feet per year by 2030.

(b) Section 13521 requires the department to establish uniform statewide recycling criteria for each varying type of use of recycled water where the use involves the protection of public health.

(c) The use of recycled water for indirect potable reuse is critical to achieving the state board's goals for increased use of recycled water in the state. If direct potable reuse can be demonstrated to be safe and feasible, implementing direct potable reuse would further aid in achieving the state board's recycling goals.

(d) Although there has been much scientific research on public health issues associated with indirect potable reuse through groundwater recharge, there are a number of significant unanswered questions regarding indirect potable reuse through surface water augmentation and direct potable reuse.

(e) Achievement of the state's goals depends on the timely development of uniform statewide recycling criteria for indirect and direct potable water reuse.

(f) This chapter is not intended to delay, invalidate, or reverse any study or project, or development of regulations by the department, the state board, or the regional boards regarding the use of recycled water for indirect potable reuse for groundwater recharge, surface water augmentation, or direct potable reuse.

(g) This chapter shall not be construed to delay, invalidate, or reverse the department's ongoing review of projects consistent with Section 116551 of the Health and Safety Code.

13561. For purposes of this chapter, the following terms have the following meanings:

(a) "Department" means the State Department of Public Health.

(b) "Direct potable reuse" means the planned introduction of recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant.

(c) "Indirect potable reuse for groundwater recharge" means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code.

(d) "Surface water augmentation" means the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply.

(e) "Uniform water recycling criteria" has the same meaning as in

Section 13521.

13561.5. The state board shall enter into an agreement with the department to assist in implementing this chapter.

13562. (a) (1) On or before December 31, 2013, the department shall adopt uniform water recycling criteria for indirect potable reuse for groundwater recharge.

(2) (A) Except as provided in subparagraph (C), on or before December 31, 2016, the department shall develop and adopt uniform water recycling criteria for surface water augmentation.

(B) Prior to adopting uniform water recycling criteria for surface water augmentation, the department shall submit the proposed criteria to the expert panel convened pursuant to subdivision (a) of Section 13565. The expert panel shall review the proposed criteria and shall adopt a finding as to whether, in its expert opinion, the proposed criteria would adequately protect public health.

(C) The department shall not adopt uniform water recycling criteria for surface water augmentation pursuant to subparagraph (A), unless and until the expert panel adopts a finding that the proposed criteria would adequately protect public health.

(b) Adoption of uniform water recycling criteria by the department is subject to the requirements of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

13563. (a) (1) On or before December 31, 2016, the department, in consultation with the state board, shall investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for direct potable reuse.

(2) The department shall complete a public review draft of its report by September 1, 2016. The department shall provide the public not less than 45 days to review and comment on the public review draft.

(3) The department shall provide a final report to the Legislature by December 31, 2016. The department shall make the final report available to the public.

(b) In conducting the investigation pursuant to subdivision (a), the department shall examine all of the following:

(1) The availability and reliability of recycled water treatment technologies necessary to ensure the protection of public health.

(2) Multiple barriers and sequential treatment processes that may be appropriate at wastewater and water treatment facilities.

(3) Available information on health effects.

(4) Mechanisms that should be employed to protect public health if problems are found in recycled water that is being served to the public as a potable water supply, including, but not limited to, the failure of treatment systems at the recycled water treatment facility.

(5) Monitoring needed to ensure protection of public health, including, but not limited to, the identification of appropriate indicator and surrogate constituents.

(6) Any other scientific or technical issues that may be

necessary, including, but not limited to, the need for additional research.

(c) (1) Notwithstanding Section 10231.5 of the Government Code, the requirement for submitting a report imposed under paragraph (3) of subdivision (a) is inoperative on December 31, 2020.

(2) A report to be submitted pursuant to paragraph (3) of subdivision (a) shall be submitted in compliance with Section 9795 of the Government Code.

13563.5. (a) The department, in consultation with the state board, shall report to the Legislature as part of the annual budget process, in each year from 2011 to 2016, inclusive, on the progress towards developing and adopting uniform water recycling criteria for surface water augmentation and its investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse.

(b) (1) A written report submitted pursuant to subdivision (a) shall be submitted in compliance with Section 9795 of the Government Code.

(2) Pursuant to Section 10231.5 of the Government Code, this section is repealed on January 1, 2017.

13564. In developing uniform water recycling criteria for surface water augmentation, the department shall consider all of the following:

(a) The final report from the National Water Research Institute Independent Advisory Panel for the City of San Diego Indirect Potable Reuse/Reservoir Augmentation (IPR/RA) Demonstration Project.

(b) Monitoring results of research and studies regarding surface water augmentation.

(c) Results of demonstration studies conducted for purposes of approval of projects using surface water augmentation.

(d) Epidemiological studies and risk assessments associated with projects using surface water augmentation.

(e) Applicability of the advanced treatment technologies required for recycled water projects, including, but not limited to, indirect potable reuse for groundwater recharge projects.

(f) Water quality, limnology, and health risk assessments associated with existing potable water supplies subject to discharges from municipal wastewater, stormwater, and agricultural runoff.

(g) Recommendations of the State of California Constituents of Emerging Concern Recycled Water Policy Science Advisory Panel.

(h) State funded research pursuant to Section 79144 and subdivision (b) of Section 79145.

(i) Research and recommendations from the United States Environmental Protection Agency Guidelines for Water Reuse.

(j) The National Research Council of the National Academies' report titled "Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater."

(k) Other relevant research and studies regarding indirect potable reuse of recycled water.

13565. (a) (1) On or before February 15, 2014, the department shall

convene and administer an expert panel for purposes of advising the department on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation and investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse. The expert panel shall assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for direct potable reuse. The expert panel shall then recommend an approach for accomplishing any additional needed research regarding uniform criteria for direct potable reuse in a timely manner.

(2) The expert panel shall be comprised, at a minimum, of a toxicologist, an engineer licensed in the state with at least three years' experience in wastewater treatment, an engineer licensed in the state with at least three years' experience in treatment of drinking water supplies and knowledge of drinking water standards, an epidemiologist, a limnologist, a microbiologist, and a chemist. The department, in consultation with the advisory group and the state board, shall select the expert panel members.

(3) Members of the expert panel may be reimbursed for reasonable and necessary travel expenses.

(b) (1) On or before January 15, 2014, the department shall convene an advisory group, task force, or other group, comprised of no fewer than nine representatives of water and wastewater agencies, local public health officers, environmental organizations, environmental justice organizations, public health nongovernmental organizations, the department, the state board, the United States Environmental Protection Agency, ratepayer or taxpayer advocate organizations, and the business community, to advise the expert panel regarding the development of uniform water recycling criteria for direct potable reuse and the draft report required by Section 13563. The department, in consultation with the state board, shall select the advisory group members.

(2) Environmental, environmental justice, and public health nongovernmental organization representative members of the advisory group, task force, or other group may be reimbursed for reasonable and necessary travel expenses.

(3) In order to ensure public transparency, the advisory group established pursuant to paragraph (1) shall be subject to the Bagley-Keene Open Meeting Act (Article 9 (commencing with Section 11120) of Chapter 1 of Part 1 of Division 3 of Title 2 of the Government Code).

(c) On or before June 30, 2016, the department shall prepare a draft report summarizing the recommendations of the expert panel.

(d) The department may contract with a public university or other research institution with experience in convening expert panels on water quality or potable reuse to meet all or part of the requirements of this section should the department find that the research institution is better able to fulfill the requirements of this section by the required date.

13566. In performing its investigation of the feasibility of developing the uniform water recycling criteria for direct potable reuse, the department shall consider all of the following:

(a) Recommendations from the expert panel appointed pursuant to

subdivision (a) of Section 13565.

(b) Recommendations from an advisory group, task force, or other group appointed by the department pursuant to subdivision (b) of Section 13565.

(c) Regulations and guidelines for these activities from jurisdictions in other states, the federal government, or other countries.

(d) Research by the state board regarding unregulated pollutants, as developed pursuant to Section 10 of the recycled water policy adopted by state board Resolution No. 2009-0011.

(e) Results of investigations pursuant to Section 13563.

(f) Water quality and health risk assessments associated with existing potable water supplies subject to discharges from municipal wastewater, stormwater, and agricultural runoff.

13567. An action authorized pursuant to this chapter shall be consistent, to the extent applicable, with the federal Clean Water Act (33 U.S.C. Sec. 1251 et seq.), the federal Safe Drinking Water Act (42 U.S.C. Sec. 300f et seq.), this division, and the California Safe Drinking Water Act (Chapter 4 (commencing with Section 116270) of Part 12 of Division 104 of the Health and Safety Code).

13569. The department may accept funds from nonstate sources and may expend these funds, upon appropriation by the Legislature, for the purposes of this chapter.