NATIONAL WATER RESEARCH INSTITUTE

Volume II

Expert Panel on the Development of Water Recycling Criteria for Indirect Potable Reuse (IPR) through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse (DPR)

for the
State Water Resources Control Board
Division of Drinking Water
(Agreement No. 13-21041)

Draft Final Panel Meeting Report: Panel's Initial Discussions on the Draft Surface Water Augmentation IPR Preliminary California Regulation Concept (Dated July 2014)

Based on a Panel Meeting Held July 24-25, 2014
Meeting #2

February 18, 2015
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.

For more information, please contact:

National Water Research Institute
18700 Ward Street
P.O. Box 8096
Fountain Valley, California 92728-8096 USA
Phone: (714) 378-3278
Fax: (714) 378-3375
www.nwri-usa.org
www.nwri-usa.org/ca-panel.htm

Jeffrey J. Mosher, Executive Director
Gina Melin Vartanian, Editor

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The Drinking Water Program was officially transferred from CDPH to the State Water Resources Control Board (SWRCB) and renamed as the Division of Drinking Water (DDW) on July 1, 2014. Financial support for the Panel is being provided by DDW through Agreement No. 13-21041.

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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 and members of DDW's Direct Potable Reuse (DPR) Advisory Committee for participating in the second 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.

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ITEM 1:

SUPPORTING MATERIAL FOR DRAFT SURFACE WATER AUGMENTATION CRITERIA (DATED JULY 2014), PREPARED BY DDW

DIVISION OF DRINKING WATER EXPERT PANEL:
Development of Water Recycling Criteria for Indirect Potable Reuse through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse

Supporting Material for Draft Surface Water Augmentation Criteria
July 2014

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California Potable Reuse Organism Log Reductions

Division of Drinking Water

The log reduction values (LRVs) herein are used in the California groundwater recharge IPR regulation, surface water augmentation IPR regulation preliminary draft, and DPR regulation concept. They may be achieved by adding the LRVs of all validated barriers occurring between the raw sewage and finished drinking water.

The LRVs are determined by calculating a ratio of the maximum organism density found in raw sewage (rounded up to one significant figure) and the density necessary to limit the annual risk of infection to 1 in 10,000. The maximum raw sewage density was used because the criteria are intended to protect the public during the worst-case exposure (microbial illness on the sewer-shed). The raw sewage density was used, rather than secondary or filtered and disinfected effluent, because of the great variation in the organism reduction effectiveness of wastewater treatment processes.

Following are the LRVs and the values used in their calculation.

	Enteric virus	***Giardia***	***Cryptosporidium***
Raw sewage maximum density	1E05 virus/L[1]	1E05 cysts/L[1]	1E04 oocysts/L[2]
Tolerable drinking water density	2.2E-07 virus/L[3]	6.8E-06 cysts/L[3]	1.7E-06 oocysts/L[4]
Ratio of drinking water to sewage density	2.2E-12	6.8E-11	1.7E-10
Required log reduction	12	10	10

[1] The high enteric virus and cyst concentrations from Water Reuse, Metcalf and Eddy, 2007, Table 3-7

[2] An oocyst concentration of 1E04 based on Norway and Melbourne data (rounded up):

- Appl Environ Microbiol. 2006 August; 72(8): 5297–5303. Occurrence of Cryptosporidium Oocysts and Giardia Cysts in Sewage in Norway; L. J. Robertson, L. Hermansen, and B. K. Gjerde
- Robertson et al. (2006), Tetra Tech (2011)

[3] Regli, S., et al., 1991, Modeling the risk from Giardia and viruses in drinking water, JAWWA, V83(11), pp 76-84

[4] LongTerm2 Surface Water Treatment Rule, [Federal Register: January 5, 2006 (Volume 71, Number 3)][Rules and Regulations] [Page 653-702] – using the high infectivity rate

Surface Water Augmentation (SWA) - Where Should the Log Reduction Values (LRVs) and Advanced Treatment Go?

Division of Drinking Water

There are advantages to placing treatment for pathogens and chemicals both prior to discharge to the reservoir and after withdrawal from the reservoir. Treatment prior to discharge provides maximum protection to the various reservoir uses and minimizes the potential for degradation of the reservoir water quality. Treatment after the reservoir provides maximum enhancement of drinking water quality. San Diego says their public outreach suggests the highly treated water should not be re-contaminated with reservoir water.

Organism LRVs:

The LRVs for organisms (12-log virus/10-log Giardia/10-log Cryptosporidium) can be achieved across all pathogen barriers between the raw sewage and the drinking water distribution system. There are three locations where organism reduction treatment can physically occur for SWA; prior to discharge to the reservoir, in the reservoir, and post reservoir (at the SWT plant). Treatment prior to discharge provides protection for all beneficial uses of the reservoir and water downstream of the reservoir, including recreation. Treatment post reservoir provides the maximum benefit for the drinking water because the LRVs are applied to all microbes entering the reservoir.

The minimum SWTR LRVs (4-log virus/3-log Giardia/2-log Cryptosporidium) must be achieved post reservoir to satisfy the Long Term 2 Enhanced SWTR to address organisms that enter the reservoir from environmental and non-SWSAP waste sources. There are minimum LRVs that must be provided prior to discharge to avoid impairing the reservoir as a source of drinking water (i.e. treat the discharge water to produce a reservoir source that will be microbiologically safe drinking water with the minimum surface water treatment required by the SDWA).

There may be a minimum LRV that must be achieved prior to discharge to the reservoir to protect beneficial uses of the reservoir other than domestic use and any use that may occur downstream of the reservoir). Is there a need to consider this issue in the SWA regulations?

Reservoir retention can reliably provide an LRV for some organisms. LRVs provided by the reservoir can be used to meet the total LRV requirement but does not provide either benefit identified in the first paragraph. A reservoir retention LRV was included in the San Diego SVR concept approval and it seems reasonable that this reservoir benefit should be recognized in regulation.

TOrC Treatment:

It is difficult to separate the TOrC treatment from LRVs because the advanced treatment required for organic chemicals provides much of the total LRV required. Providing the advanced organic chemical treatment prior to the reservoir keeps the reservoir from being chemically degraded and minimizes the chance of aesthetic water quality problems. Post reservoir treatment yields the chemically purest drinking water.

Surface Water Augmentation (SWA)
Dilution is a Horse of a Different Color

Division of Drinking Water

Groundwater Recharge IPR:

"Dilution" and requirements for "diluent water" are used to meet contaminant reduction requirements in the groundwater recharge IPR regulation. Therein dilution (using the reclaimed water contribution [RWC] requirement) is primarily intended for use in concert with surface spreading to reduce the concentration of potentially harmful unregulated organic chemicals. Dilution must work with soil-aquifer treatment to achieve the 0.5 mg/L TOC performance standard for the spreading projects because the soil-aquifer treatment alone will not remove recalcitrant organic chemicals. To accomplish this objective the diluent water must be relatively free of the contaminants of concern and be obtained from waters other than reclaimed wastewater.

One secondary use of dilution for groundwater recharge IPR is to manage the mobilization of contaminants that can occur when RO permeate is injected into an aquifer.

Surface Water Augmentation IPR:

The purpose of dilution for SWA is not to meet a chemical quality standard because all the reclaimed water is treated to the quality standard using advanced treatment (RO/AOP). In SWA the benefit of dilution is to reduce the consequence of a treatment failure. Where significant mixing of advanced treated water with reservoir water (any combination of watershed runoff, imported, or advanced treated recycled water meeting treatment requirements) occurs any short-term discharge off-spec water will be mitigated. The dilution may not be credited as part of the treatment train for contaminants.

Question:

Due to the different purposes of dilution and diluent water source for the different types of IPR (it may ultimately be mostly advanced treated recycled water for SWA) it may be desirable to use a distinct terms to avoid confusion. The "diluent water" definition in the groundwater replenishment regulation is not appropriate for SWA because it includes the term "over time".

ITEM 2:

CALIFORNIA DIRECT POTABLE REUSE INITIATIVE RESEARCH BRIEFING (DATED JULY 2014), PREPARED BY WRRF AND WATEREUSE CALIFORNIA



California Direct Potable Reuse Initiative Research Briefing

July 2014

WATEREUSE RESEARCH

WATEREUSE CALIFORNIA

Goal of this document

The goal of this briefing document is to provide project updates the CDPH Expert Panel in advance of their regular meetings. The *California Direct Potable Reuse Initiative Research Plan* should be referenced for more information.

DPR Research Project Update

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

   Project Duration:

   - Project Start – June 2012
   - Draft Report Due – December 2014
   - Estimated Publication Date – September 2015

   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 eighth progress report in July 2014 and will be submitting their ninth and final progress report in September 2014.

   Notable Update:

   Task 2 is complete at this time aside from analyzing the reverse osmosis trials. The purpose of this task is to identify correlations between treatment performance and sensor response. As part of this task the following was 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 WRRF-11-01 Task 2

Real UVT Online	MicroTol3 Turbidity Analyzer	GuardianBlue Event Monitor	Sievers 5310C On-Line TOC Analyzer	Spectro::lyser	NiCaVis 705 IQ	SAFire	BioSentry	BioScan (RMS-W)	ToxControl Toxicity Analyzer

General parameters		Organic parameters		Inorganic parameters		Microbial parameters	
pH	GuardianBlue Event Monitor	UVT 254 (%)	Real UVT Online	Chlorine (mg/L)	GuardianBlue Event Monitor	Total cell count (counts/100mL)	BioSentry, BioScan (RMS-W)
Temperature (°C)	GuardianBlue Event Monitor	UVA 254 (cm^{-1})	Real UVT Online, NiCaVis 705 IQ	NO_3-N (mg/L)	Spectro::lyser, NiCaVis 705 IQ	Toxicity (%)	ToxControl Toxicity Analyzer
Conductivity (µS/cm)	GuardianBlue Event Monitor	DOC (mg/L)	Spectro::lyser, NiCaVis 705 IQ				
Turbidity (NTU)	GuardianBlue Event Monitor, Spectro::lyser, MicroTol3 Turbidity Analyzer	TOC (mg/L)	GuardianBlue Event Monitor, Spectro::lyser, Sievers 5310C On-Line TOC Analyzer, NiCaVis 705 IQ				
		Fluorescence (A.U.)	SAFire				

Preparations are underway for Task 3. The first pilot scale test will be conducted at the Tucson Water Sweetwater Recharge Facility. To accommodate this test, considerable up front preparations have been necessary:

1. Design and construction of a small building to house the on-line sensors (complete)
2. Transport and installation of sensors from the Sensor Lab to the new building (complete)
3. Installation of electrical hardware (complete)

In July, the first pilot scale testing will be conducted at this facility and the data will be reported in the next Progress Report.

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
- Two new sensors for microbial analyses installed
- RO tests almost complete (Laboratory scale)
- Advanced oxidation via UV evaluated in two secondary effluents for removal of contaminants (Laboratory scale)
- Pilot scale evaluations will begin shortly
- A workshop will be held in September in coordination with the WateReuse Symposium to discuss the preliminary results from this project

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

Project Duration:

- Project Start – May 2012
- Draft Report Due – October 2014
- Estimated Publication Date – September 2015

This project will clearly identify the benefits and tradeoffs of various treatment process trains for potable reuse and 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 team submitted their eighth progress report in May 2014 and is expected to submit their ninth and final progress report in July 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.

Task 1 has been completed and the following has been completed:

- A report examining the criteria for direct potable reuse was completed and released in 2012 (WRRF-11-02-01). The purpose of this report was to develop a

set of criteria that are protective of public health to evaluate treatment technologies for DPR.

- A State of the Science Report was completed and released in 2012 (WRRF-11-02-02). This report provides an overview of the current state of the science of potable reuse including both domestic and international perspectives. This report also developed criteria for determining equivalency with regard to the three main categories of interest: microbial, chemical, and aesthetic criteria.
- This task was completed alongside an expert panel workshop that was co-run with NWRI

In Task 2, the project team has completed or almost completed the following:

- Potential treatment trains for near-full-scale direct potable reuse testing have been identified.
- 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.
- A user manual for the digital toolbox.

In Task 3, the following has been accomplished:

- The project team has developed a draft test protocol based on these treatment trains and the availability of pilot equipment.
- Pilot testing at San Luis Obispo Water Reclamation Plant (WRP) was performed in March 2013 and July 2013. 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 and Leopold systems began operating in June 2013, and the Econity, GE and RO skids began operating in September 2013. Phase 1 testing of pilot scale UF-O_3-BAC with bench-scale UV photolysis and pilot-scale MF-RO with bench-scale UV/H_2O_2 and free chlorine disinfection was completed the first week of December 2013. Bench-scale testing of UV photolysis, UV/H_2O_2 and free chlorine disinfection was performed in October 2013. Follow up testing to minimize the chlorate concentration after free chlorine disinfection and to spike 1,4-dioxane before UV/H_2O_2 were performed a few weeks later.
- The transition to Phase 2 testing of pilot-scale O3-BAC-UF with bench-scale UV photolysis (Train 1a) and pilot-scale O_3-MF-RO with bench-scale UV/H2O2 (Train 2) was completed the first week of December 2013. Operation of these treatment trains ended in the middle of February 2014 and was followed by 2 weeks of testing UF-O_3-BAC with alum addition before the UF pilot unit. Phase 2 testing

ended in early March, and the GE UF pilot until and H2O Engineering ozone pilot unit were returned to the vendors.

- Phase 3 testing of MF-O_3-BAC began in late March is scheduled to end in late May, with the final month of Phase 3 testing O_3-BAC-MF. This was expected to be completed in June.
- The first sets of quarterly samples were collected from El Paso Water Utilities' (EPWU's) Fred Hervey Water Reclamation Plant and Upper Occoquan Service Authority's (UOSA's) Millard H. Robbins Jr. Water Reclamation Plant in November 2013. The second and third rounds of quarterly sampling at these treatment plants were conducted in January and April 2014. The final set of samples is expected to be collected in July.

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

   Published May 2014, available in dropbox: Click here to view DPR Folder

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

   Expected publication: July 2014

   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 July 31, 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. WRRF-12-06, *Guidelines for Engineered Storage for Direct Potable Reuse Systems* (Contractor: Carollo Engineers)

   Project Duration:

   - Project Start – March 2013
   - Draft Report Due – July 2014
   - Estimated Publication Date – May 2015

   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 third (and last) progress report was submitted during the quarter. The project is delayed by about two months due to difficulty in collecting data from utilities and the draft report is expected by July 31, 2014.

   Notable Update: An animated video called "The Ways of Water" was developed as part of Task 3 (Examining Public Perception) and is being used as a way to inform survey participants as a way they chose to examine current attitudes about DPR. As part of a recent workshop, the video was shared with a few utilities which have indicated their desire to use it when meeting with news staff, tour participants, or on other occasions that they need to explain DPR to people who are not familiar with the terms. The video is currently available on the Foundation's website.

   In the last quarter, significant progress was made toward the completion of each of the tasks, as the project work is nearing completion. The project team will complete all tasks by the time of the Draft Report Submission in July.

   Task 1. Literature Review and Knowledge Transfer

   The literature review was summarized in the previous progress report. Water quality data is being collected from existing potable reuse treatment schemes to better understand product water quality variability. At this time, data:

   - El Paso Water Utilities / Fred Hervey Water Reclamation Plant. This includes data collected at 7 locations throughout the plant from January 2012 through September 2013. Analytes vary by sample location, but include bulk water quality parameters such as BOD, COD, TSS, TKN as well as individual anions and

cations, metals, pesticides, nutrients, and VOCs. Additional data were requested, specifically with respect to NDMA and constituents of emerging concern, however EPWU indicated that these are not measured at this facility.

- West Basin Municipal Water District. The District has provided a large quantity of data, which have not yet been analyzed.
- The City of San Diego. San Diego has also provided a large quantity of data, which have not yet been analyzed.
- Windhoek, Namibia. Windhoek has provided general water quality data for several locations within their treatment train.
- Orange County Water District. The District has provided a large quantity of analytical data, including many classes of organic compounds (trace chemicals, volatiles, nitrosamines, hormones, pesticides, metals, general water quality parameters, and more), for several locations within their advanced treatment train.

The project team will continue to collect data from the participating utilities. These data will be analyzed for water quality variability and other trends once data are obtained from all parties.

Task 2. Design of Engineered Storage Systems

A framework for engineered storage sizing was developed and introduced at the workshop held 9/16/13 and 9/17/13, as described in the previous progress report. A draft framework for sizing engineered storage systems was submitted with progress report #2 in November 2013. Additional updates to the framework were made in response to PAC and internal review comments.

Task 3. Public Perception Surveys

The public perception survey is based first upon the public reviewing a short educational video, before answering survey questions. The video is now complete and can be viewed at the following web address: https://vimeo.com/84750029 with the password "watershed"

The survey questions are in draft form, and are being shared with several utility partners, and can also be found at the following web address:
https://www.surveymonkey.com/s/water_test

Task 4. Utility Case Studies

The following utilities were contacted to kick off case studies: City of LA, UOSA, El Paso, and Lubbock. A meeting was held on March 13, 2014 with the City of Los Angeles to discuss their case study, others followed in April and May. These case studies will serve to illustrate concrete examples of engineered storage buffers, including size, volume, physical configuration, and operation.

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

Project start date: July 15, 2013

Draft report due: January 1, 2016

Estimated publication date: December 2016

The objective of this project 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.

The project approach consists of five tasks:

1. Literature Review
2. Two workshops
3. Identification of Integrity Indicators
4. Development of Method for Integrity Testing
5. Evaluating Developed Method at Pilot Scale

Status: The project team is currently working on their fourth progress report out of nine, which is due on July 14, 2014. The third progress report is available in dropbox.

Notable Update: Two workshops were conducted to define best approaches towards integrity monitoring of NF and RO membranes. The first workshop was conducted on April 24 in Melbourne, Australia. This workshop was coordinated by Water Services Association of Australia (WSAA). Representatives from water utilities attended in person at WSAA's Melbourne office and also via teleconference. The second workshop was conducted on April 28 in Arcadia, California. This workshop was conducted via teleconference and consisted of participants from water utilities, membrane manufacturers, integrity monitoring technology provides, and members of the Project Advisory Committee. Meeting minutes for both workshops and the presentation slides are available as a part of the third progress report in dropbox.

Key Workshop Findings:

- Ideal integrity monitoring technique should be on-line and real time to satisfy regulators
- On-Line TOC instruments are expensive ($40,000-$50,000 per unit; $3,000 per year operation and maintenance) with maintenance problems.
- Rhodamine WT (RWT) dye is being used at a full-scale plant to obtain 1.5 Log Reduction Value (LRV) credit from regulators. Challenge testing is performed once a year.
- Challenge testing with MS2 bacteriophage could be a cost-effective option if the water utility has its own lab capabilities.

Progress to date:

- The literature review (Task 1) has been completed and approved by the PAC.

- Both workshops have been successfully completed (Task 2). As suggested by a PAC member during the U.S. workshop, the project team is currently working on a scoring/ranking system for all technologies evaluated in the literature review. The ranking system will be presented in the fourth progress report.
- Task 3 is currently in progress. The objective of this task is to identify indicative parameters in various source water types to yield at least 4 log removal of microorganisms by NF and RO membranes. Indicative parameters, such as total organic carbon (TOC) and chemical oxygen demand (COD), are being measured at the bench-scale. Results will be presented in the fourth progress report.

7.WRRF-13-02, *Model Public Communication Plan for Advancing DPR Acceptance* (Contractor: Data Instincts)

Project Duration:

- Project Start – November 2013
- Draft Report Due – July 2014
- Estimated Publication Date – January 2015

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 research approach was designed to lay the groundwork for development of communication plans that could be replicated by agencies pursuing DPR projects, and which could be tailored to specific communities and for state WateReuse sections. To that end, during this last quarter a variety of communication research efforts were conducted, utilizing in-depth interviews (IDIs), surveys and focus groups among key target audiences identified in Task 2. Responses to questions were noted and results collated to reveal trends or important repeated themes. The information gleaned from these efforts has been used to develop the following documents: a) State Level Communication Plan, b) Community Level Communication Plan, and c) Guidance for Utilities on Working with Community Leaders. These communication plans will guide industry leaders, utilities and those communities considering new water supply options to include potable reuse as well in a thoughtful review process.

The second PAC workshop was held July 9, 2014. In the workshop the team highlighted those messages and/or approaches which emerged as promising, based on input we received in focus groups and telephone surveys conducted in our two identified model communities (San Diego and the service area for the Santa Clara Valley Water District). The group also discussed recommendations on how best to proceed in the subsequent Phases II & III of 13-02.

Project Progress: Model Public Communication Plan for Advancing DPR Acceptance

Task 1 – Situational Analysis Background/Initial Assessment 100%

Task 2- Identify Key Guidance Factors 100%

Task 3 - Strategic Communication Development/Conduct IDIs, surveys and focus groups 100%

Task 4 – Plan Refinements/Calibrate Next Steps

A. Develop Draft State Level Communication Plan 85%

B. Develop Draft Community Level Communication Plan 85%

C. Develop Draft Guidance for How Utilities can Engage Community Leaders 85%

Notable updates: The work was presented by Mark Millan at several recent events:

- March 24 & 25, 2014 - AWRCE Goal 3 Project in Brisbane, Australia
- April 2, 2014 - AWWA Sustainable Management Conference in Denver, CO
- May 18, 2014 WRA and WRRF Boards/Research Conference in Las Vegas, NV
- May 20, 2014 WRRF DPR Collaborative Meeting in Las Vegas, NV

In an effort to explore approaches that have been tried elsewhere, our team was invited to Australia during this last quarter. Our project research manager, Stefani McGregor, along with two of our PAC members (Ron Wildermuth and Dave Smith) and Mark Millan, were graciously received by the Australian Water Recycling Centre of Excellence (AWRCoE) and members of their NDEEP team (National Demonstration Education and Engagement Program). They visited the Bundamba Advanced Water Treatment Plant and received an overview of South East Queensland and its history of challenges with water supply and water reuse. A two-day forum with presentations from the respective project teams provided an opportunity to explore cross-linkages and potential collaboration between AWRCoE and both projects (NDEEP and WRRF 13-02). Their Goal 3: "*Reclaimed water is viewed as acceptable 'alternative water' for augmenting drinking water supplies"* is very similar to our 13-02 project Goals and Objectives.

From the Brisbane meetings and subsequent discussion between Foundation and AWRCoE leadership, it is acknowledged that there are real opportunities for collaboration and sharing of information, messages and materials that could be extremely beneficial to both organizations and countries. Conversation continues between the WRRF and AWRCoE.

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

Project Duration:

- Project Start – December 2013
- Draft Report Due – July 2015
- Estimated Publication Date – April 2017

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:

A workshop was conducted in Tempe, Arizona, on February 25 and 26 with a multi-disciplinary Hazard Analysis and Critical Control Points (HACCP) team. The purpose of this workshop was to fully vet the water quality objectives, critical control points, and final list of chemical and microbial indicators and surrogates. Some key findings include:

- General water quality risks (grouping of classes of contaminants and microbes) were considered for this workshop as a means of optimizing the use of time. A detailed water quality risk assessment will be developed subsequent to the workshop by selected members of the team.
- The water quality targets for DPR included meeting all Federal drinking water standards as well as conforming to the pathogen reduction goals in the draft CA Groundwater Recharge Regulations including the "12-10-10" rule for virus, cryptosporidium, and giardia inactivation.
- Critical control point analysis was conducted and control points determined were reviewed for both the "FAT" of MF/UF-RO-UV/H_2O_2-Cl_2, and the alternative treatment process of O_3-BAC-GAC-UV-Cl_2.

Operating data is continuing to be gathered from participating utilities, for use in the Monte Carlo analysis and planning of full scale operational challenge testing at Scottsdale Water Campus will begin. Progress Report #2 of 5 will be submitted in July.

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

Project Duration:

- Project Start – May 2014

- Draft Report Due – June 2015
- Estimated Publication Date – June 2016

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: Black & Veatch (PI Alan Rimer) began project work as of June 1, 2014. The kickoff call is being planned for August and the first progress report will be due September 1, 2014.

10. WRRF-13-13, *Operations Plan Development Standard* (Contractor Hazen & Sawyer)

Project Duration:

- Project Start – May 2014
- Draft Report Due – July 2015
- Estimated Publication Date – April 2016

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: Hazen & Sawyer (PI Troy Walker) has been awarded and the project was started in May. The first Progress Report is due in August.

11. WRF 4536, *Blending Requirements for Water from DPR Treatment Facilities* (Contractor: Carollo; funded and 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 project was awarded to Carollo (Andrew Salveson, PI), and the project will begin soon.

12. WRF 4508, *Assessment of techniques for evaluating and demonstrating safety of DPR product water* (Contractor: U of Arizona; funded and 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 project was awarded to U of Arizona (Channah Rock, PI), and the project will begin soon.

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 approved by the Board in late March. A PAC has been formed and the RFP is expected summer 2014.

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 approved by the Board in late March. A PAC has been formed and RFP is being revised for release in July 2014.

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

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

Project Update: This project was developed by the RAC in their January 2014 meeting and approved by the Board in late March. A PAC has been formed and the RFP is expected summer 2014.

16. WRRF-14-08, Economics of Direct Potable Reuse (Contractor: Stratus Consulting)

The objective of this project is to estimate the capital costs of DPR using existing treatment technologies (including monitoring equipment) along with an estimate of the operating costs. These estimated costs and the energy requirements, including GHG emissions, will be compared to other sources of water including imported water, local surface and groundwater, brackish groundwater desalination, and seawater desalination. This will primarily focus on California. The potential cost savings from choosing DPR over alternatives will be estimated as well. In addition, the estimated total volume of "new water" that could be generated from DPR in California will be estimated.

Project Update: This project was sole-sourced to Bob Raucher (Stratus Consulting) and began in April. A draft report was submitted in June with a final report expected in the next few months.

17. WRRF-14-10, Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring Texas (Contractor: Carollo)

Project Duration:

- Project Start – August 2014
- Estimated Draft Report Due – August 2015
- Estimated Publication Date – March 2017

The objective of this project is to create a DPR Monitoring Guidelines document that makes recommendations for long-term monitoring at facilities like the one at Big Spring. It will take into account the results of the in-depth sampling conducted during this study, and develop a robust monitoring approach to reduce risk to public health while keeping

costs low through the use of appropriate process monitoring and surrogate measurements.

A team led by Carollo was recently awarded a grant funded by the Texas Water Development Board (TWDB) to study the water quality delivered by the RWPF. This team is in the process of developing a testing protocol to demonstrate the water quality produced by RWPF. As part of this testing, state of the art online monitoring approaches and surrogate testing are proposed to compliment analyses for pathogens (virus, protozoa, and bacteria) and trace pollutants (pharmaceuticals, endocrine disruptors, disinfection by products, flame retardants, perfluorinated compounds, and others).

The current study provides a detailed review of system performance in accordance with public health and Texas Commission on Environmental Quality (TCEQ) regulatory objectives. The additional funding from WRRF for this TC project allows a substantial expansion of project scope and value. This additional sampling and laboratory work would be done concurrent with funded efforts. This additional research will increase the breadth and statistical accuracy of the data set, which is necessary for this research to have national recognition.

Project Update: This project was accepted as part of the Tailored Collaboration Program in May 2014. A PAC is being formed and the project is expected to begin August 1, 2014.

18. WRRF-14-12, Failsafe Potable Reuse Project at the City of San Diego's Advanced Water Purification Demonstration Facility (Contractor: Trussell Technologies)

This project will develop and examine a conceptual framework for a direct potable reuse facility for the California Department of Public Health (CDPH) at the City of San Diego's newly upgraded Advanced Water Purification Demonstration Facility (AWPF). It is envisioned that the conceptual framework will address issues beyond the treatment plant, such as source control, required operator training and certification, product water delivery and mixing strategies/requirements, as well as a plan to provide an alternative potable water supply in emergency scenarios and to ensure that extreme events do not compromise public health. There could be other necessary components of this framework that have yet to be defined. However, these aspects of the framework are not the focus of the specific testing program of the project, which will focus on demonstrating that a proper combination of today's established treatment technologies and on-line monitors are capable of providing the backbone of a reliable potable reuse project. The AWPF treatment plant has been modified to incorporate redundancy, both in treatment processes and on-line monitors; so that it can be ensured that adequate barriers are always in place to protect public health. The AWPF also incorporates a robust treatment train with diverse processes that are able to address various contaminants at varying concentrations. The demonstration facility will be evaluated in a manner that aims to demonstrate that the environmental buffer used in today's potable reuse projects in California can be eliminated. The project will be highlighted by an expert panel workshop that will consider the knowledge base developed by the WateReuse Research Foundation to date in outlining specific guidelines that will better define the needs of a direct potable reuse facility. Per Senate Bill 918, the CDPH must report on the feasibility of direct potable reuse by the end of 2016 and a National Water Research Institute (NWRI) expert panel has been contracted with the State of California

to, among many other things, evaluate the feasibility of direct potable reuse. The primary goal of this project is to inform the panel discussion and engage the CDPH in concepts that will encourage direct potable reuse.

Project Update: This project should start fall 2014 after successful contract negotiation between SDCWA, City of San Diego, WRRF, and Trussell.

19. WRA-14-01, Developing Direct Potable Reuse Guidelines (Contractor: NWRI)

Project Duration:

- Project Start – April 2014
- Draft Report Due – November 2014
- Estimated Publication Date – December 2014

The project will develop a White Paper with the purpose of identifying topics and issues that need to be addressed in the development of future national potable reuse guidelines. Guidelines for potable reuse would focus on issues such as public health protection, sufficient multiple barriers, risk assessment, water quality monitoring, and operation management. At present, six U.S. states (i.e., California, Texas, New Mexico, Oregon, Florida, and Arizona) have standards and/or guidelines for potable reuse under development, while many more are interested in receiving guidance. Federal guidelines on potable reuse do not currently exist and are not expected to be forthcoming.

This White Paper will be developed by an Expert Panel conducted by NWRI. The panel will meet several times to develop a comprehensive source of information and expert judgment on DPR, eview current state standards and guidelines efforts, and review decision factors and public protection goals for DPR. The first expert panel meeting is expected to occur in August. In June, a conference call was conducted with the PAC, the Panel Chair (George Tchobanoglous), Joe Cotruvo (Panel member), and Jeff Mosher of NWRI.

Table 1. WRRF DPR Research Program 2011 – 2014

Project #	Research Project Title	Principal Investigator	Research Focus	Expected Publication	WRRF contribution	In Kind Contribution
WRRF-11-01	Monitoring for Reliability and Process Control of Potable Reuse Applications	Ian Pepper, University of Arizona	Regulatory – Process Reliability	Dec-15	$400,000	$1,298,817
WRRF-11-02	Equivalency of Advanced Treatment Trains for Potable Reuse	Rhodes Trussell, Trussell Technologies	Regulatory – Treatment	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 Group Inc	Community, Regulatory	May-14	$49,558	$10,000
WRRF-11-10	Evaluation of Risk Reduction Principles for Direct Potable Reuse	Andy Salveson, Carollo Engineers	Regulatory – Treatment	Jun-14	$73,407	$71,555
WRRF-12-06	Guidelines for Engineered Storage for Direct Potable Reuse	Andy Salveson, Carollo Engineers	Regulatory – Treatment	Jun-15	$100,000	$111,788
WRRF-12-07	Methods for Integrity Testing of NF and RO Membranes	Joe Jacangelo, MWH	Regulatory – Process Reliability	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	Community	Sep-14	$337,125	$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	Regulatory – Process Reliability	Feb-16	$300,000	$238,969
WRRF-13-12	Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR	Alan Rimer, Black & Veatch	Utility, Regulatory	Feb-16	$150,000	$81,150
WRRF-13-13	Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse (DPR) Systems	Troy Walker, Hazen & Sawyer	Utility	Feb-16	$250,000	$85,000
WRRF-13-15 (WRF4536)	Blending Requirements for Water from Direct Potable Reuse Treatment Facilities	Andy Salveson, Carollo Engineers	Utility	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	Channah Rock, University of Arizona	Utility, Regulatory	TBD	$275,000	TBD
WRRF-14-01	Integrated Management of Sensor Data for Real Time Decision Making and Response	TBD	Regulatory – Process Reliability	TBD	$300,000	TBD
WRRF-14-02	Establishing additional log reduction credits for WWTPs	TBD	Regulatory – Treatment	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	Utility	TBD	$250,000	TBD
WRRF-14-08	Economics of DPR	Bob Raucher, Stratus Consulting	Utility	Jul-14	$25,000	0
WRRF-14-10	Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring Texas	Eva Steinle-Darling, Carollo	Regulatory	Feb-16	$100,000	$561,755
WRRF-14-12	Failsafe Potable Reuse Project at the City of San Diego's Advanced Water Purification Demonstration Facility	Shane Trussell, Trussell Technologies	Utility, Regulatory	Dec-16		$3,088,313
WRA-14-01	Developing Direct Potable Reuse Guidelines	Jeff Mosher, NWRI	Regulatory	Dec-14	$53,120	0

ITEM 3:

CALIFORNIA DIRECT POTABLE REUSE INITIATIVE RESEARCH PLAN (UPDATED JULY 2014), PREPARED BY WRRF AND WATEREUSE CALIFORNIA.



California Direct Potable Reuse Initiative Research Plan

Updated July 2014

WATEREUSE RESEARCH

WATEREUSE CALIFORNIA

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

Goal of DPR Initiative

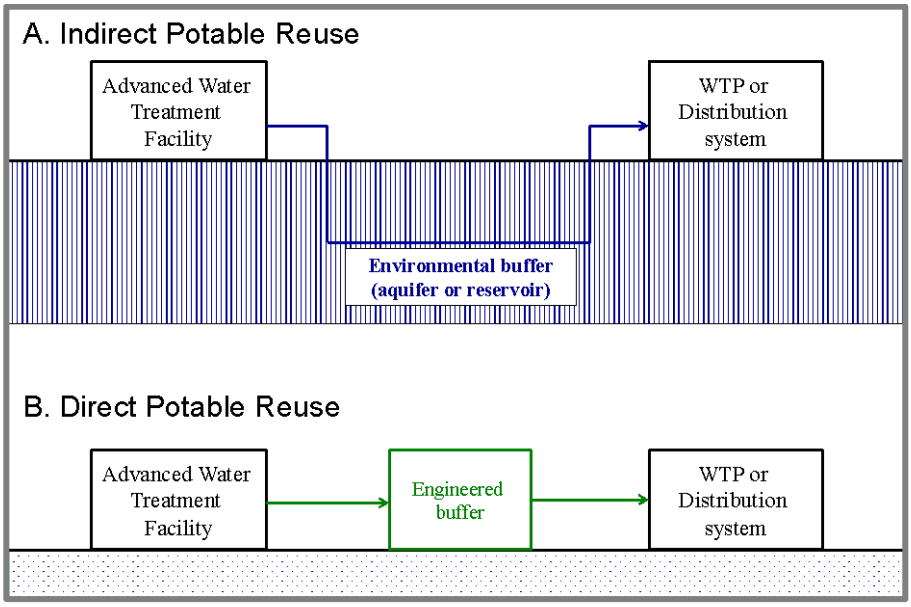
The WateReuse Research Foundation (WRRF) and WateReuse California (WRCA) have launched the CA Direct Potable Reuse (DPR) Initiative to establish DPR as a water supply option that is protective of public health and can be regulated by state agencies, can be implemented by water utilities in a safe and 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. Phases II and II of the project WRRF-13-02 will take on the outreach activities in select communities and state wide.

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.

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*

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*
- *Product water aesthetics: taste and odor*

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 (WRF4536 and 4506) 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 four new solicited research projects to be started in 2014. Those 2014 projects along with 3 additional Tailored Collaboration DPR projects add another $4.5 million to the DPR program to address technical and public acceptance concerns with DPR.

The Foundation's 19 DPR projects initiated in 2014 or before total $10.4 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	Research Focus	Expected Publication	WRRF contribution	In Kind Contribution
WRRF-11-01	Monitoring for Reliability and Process Control of Potable Reuse Applications	Ian Pepper, University of Arizona	Regulatory - Process Reliability	Dec-15	$400,000	$1,298,817
WRRF-11-02	Equivalency of Advanced Treatment Trains for Potable Reuse	Rhodes Trussell, Trussell Technologies	Regulatory - Treatment	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 Group Inc	Community, Regulatory	May-14	$49,558	$10,000
WRRF-11-10	Evaluation of Risk Reduction Principles for Direct Potable Reuse	Andy Salveson, Carollo Engineers	Regulatory - Treatment	Jun-14	$73,407	$71,555
WRRF-12-06	Guidelines for Engineered Storage for Direct Potable Reuse	Andy Salveson, Carollo Engineers	Regulatory - Treatment, Community, Utility	Jun-15	$100,000	$111,788
WRRF-12-07	Methods for Integrity Testing of NF and RO Membranes	Joe Jacangelo, MWH	Regulatory - Process Reliability	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	Community	Sep-14	$337,125	$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	Regulatory - Process Reliability	Feb-16	$300,000	$238,969
WRRF-13-12	Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR	Alan Rimer, Black & Veatch	Utility, Regulatory	Feb-16	$150,000	$81,150
WRRF-13-13	Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse (DPR) Systems	Troy Walker, Hazen & Sawyer	Utility	Feb-16	$250,000	$85,000
WRRF-13-14 (WRF4508)	Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities	Channah Rock, University of Arizona	Utility, Regulatory	Feb-16	$275,000	$144,177
WRRF-13-15 (WRF4536)	Blending Requirements for Water from Direct Potable Reuse Treatment Facilities	Andy Salveson, Carollo Engineers	Utility	Feb-16	$325,000	$403,310

WRRF-14-01	Integrated Management of Sensor Data for Real Time Decision Making and Response	TBD	Regulatory - Process Reliability	TBD	$300,000	TBD
WRRF-14-02	Establishing additional log reduction credits for WWTPs	TBD	Regulatory - Treatment	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	Utility	TBD	$250,000	TBD
WRRF-14-08	Economics of DPR	Bob Raucher, Stratus Consulting	Utility	Jul-14	$25,000	0
WRRF-14-10	Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring Texas	Eva Steinle-Darling, Carollo	Regulatory	Feb-16	$100,000	$561,755
WRRF-14-12	Failsafe Potable Reuse Project at the City of San Diego's Advanced Water Purification Demonstration Facility	Shane Trussell, Trussell Technologies	Utility, Regulatory	Dec-16	n/a	$3,088,313
WRA-14-01	Developing Direct Potable Reuse Guidelines	Jeff Mosher, NWRI	Regulatory	14-Dec	$53,120	0

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 3 shows the project duration of the 19 DPR projects underway (green is expected).

Figure 2. Venn Diagram of Reliability Framework

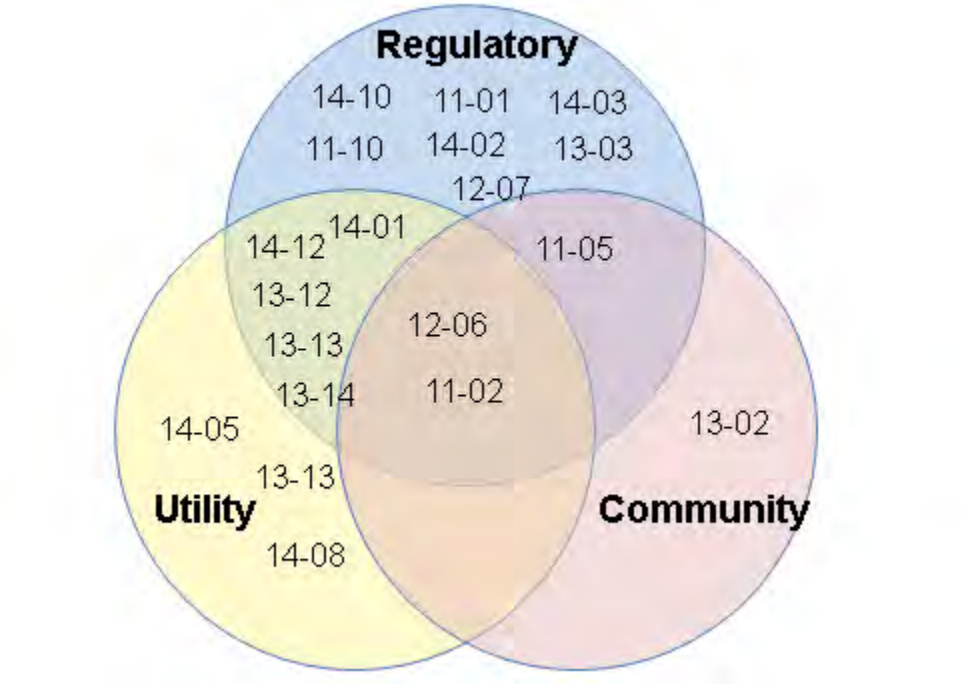
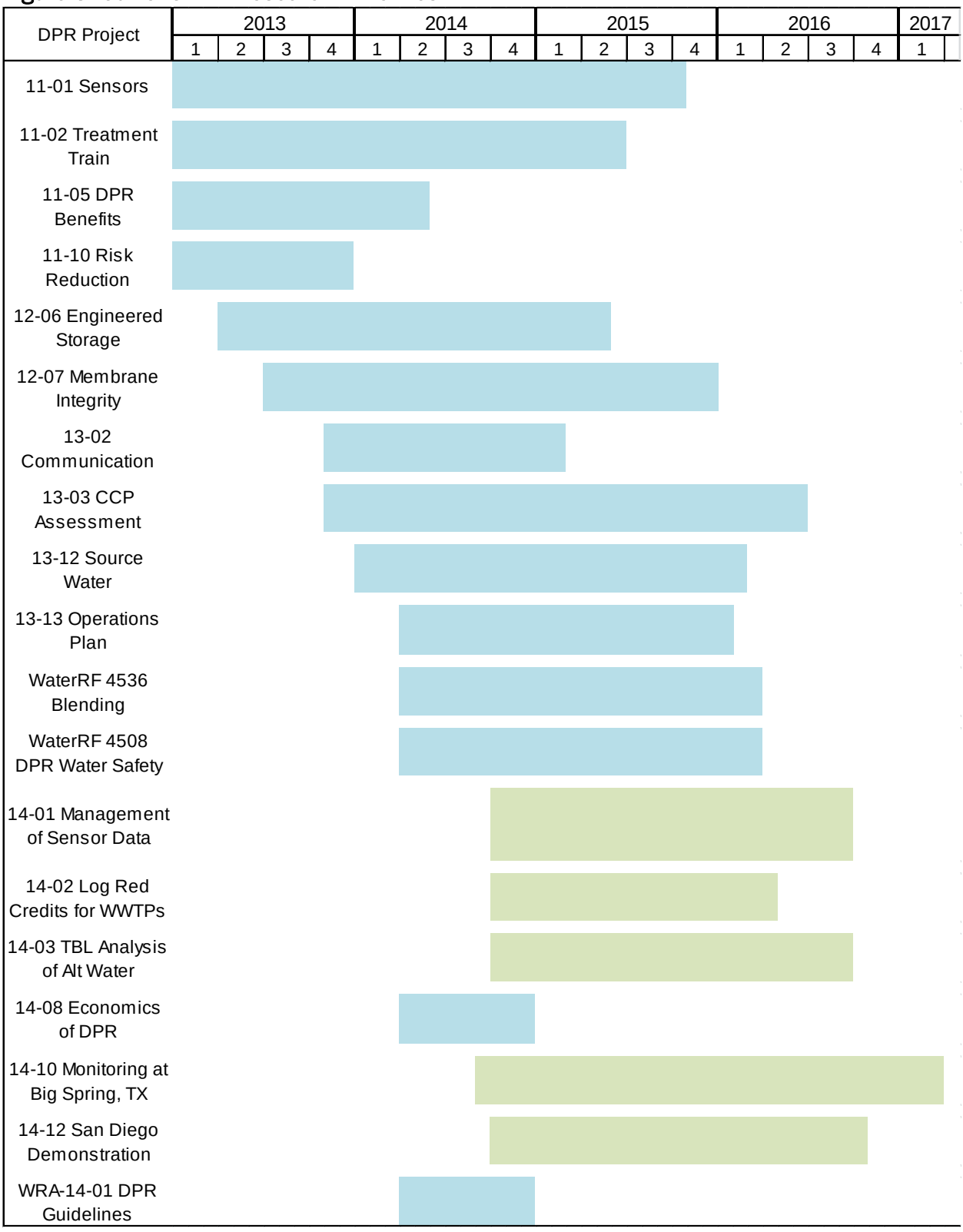


Figure 3: Current DPR Research Timelines



Section 4: Future Research and Next Steps

New DPR research will be initiated in the end of 2014 and beyond to ensure gaps are filled to illustrate the feasibility of DPR. Several sources will be considered for this new research, most importantly recommendations from the expert panel. After funding six projects in 2013 and four in 2014 and incorporating/combining descriptions, four 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 consideration of research to fund. Additionally, the recommendations of the current 19 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. Input from the CDPH Expert Panel will be utilized to steer new research.

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
Develop concepts that draw upon the existing regulatory framework for drinking water to establish the definition of reliability in potable reuse	NRC/DPR Path Forward	TBD
Identify non-RO DPR treatment options to eliminate need for brine disposal	NRC/DPR Path Forward	TBD
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-	$1,000,000

	12-01)	
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 WRRF11-02.

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

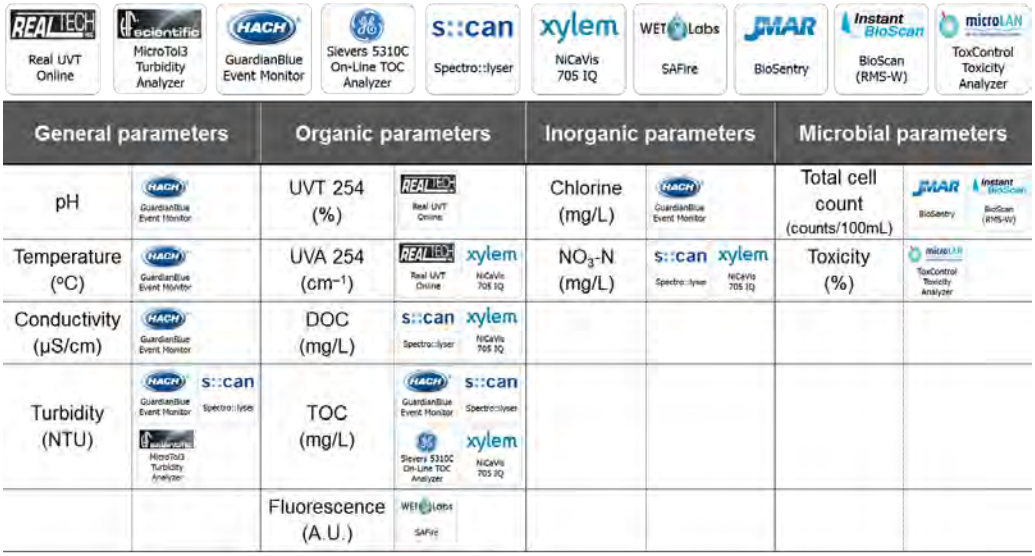
  From secondary/ tertiary treatment → *MF/UF* → O_3 → *GAC/BAC* → *From surface/groundwater augmentation*

- 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 WRRF-11-01 Task 2



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. WRRF-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. WRRF-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 has been published.

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

   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. WRRF-13-02, *Model Public Communication Plan for Advancing DPR Acceptance* (Contractor: Data Instincts)

   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. WRRF-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. WRRF-13-12, *Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR* (Contractor: Black & Veatch)

   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: Black & Veatch (PI Alan Rimer) has been awarded and the project will start soon.

10. WRRF-13-13, *Operations Plan Development Standard* (Contractor Hazen & Sawyer)

    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: Hazen & Sawyer (PI Troy Walker) has been awarded and the project will start soon.

11. WRF 4536, *Blending Requirements for Water from DPR Treatment Facilities* (Contractor: Carollo; funded and 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 project was awarded to Carollo (Andrew Salveson, PI), and the project will begin soon.

12. WRF 4508, *Assessment of techniques for evaluating and demonstrating safety of DPR product water* (Contractor: U of Arizona; funded and 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 project was awarded to U of Arizona (Channah Rock, PI), and the project will begin soon.

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 approved by the Board in late March. A PAC is being formed and RFP is expected summer 2014.

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 approved by the Board in late March. A PAC is being formed and RFP is expected summer 2014.

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

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

    Project Update: This project was developed by the RAC in their January 2014 meeting and approved by the Board in late March. A PAC is being formed and RFP is expected summer 2014.

16. WRRF-14-08, Economics of Direct Potable Reuse (Contractor: Stratus Consulting)

    The objective of this project is to estimate the capital costs of DPR using existing treatment technologies (including monitoring equipment) along with an estimate of the operating costs. These estimated costs and the energy requirements, including GHG emissions, will be compared to other sources of water including imported water, local surface and groundwater, brackish groundwater desalination, and seawater desalination. This will primarily focus on California. The potential cost savings from choosing DPR over alternatives will be estimated as well. In addition, the estimated total volume of "new water" that could be generated from DPR in California will be estimated.

    Project Update: This project was sole-sourced to Bob Raucher (Stratus Consulting) and began in April. The white paper is due to complete in July 2014.

17. WRRF-14-10, Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring Texas (Contractor: Carollo)

    The objective of this project is to create a DPR Monitoring Guidelines document that makes recommendations for long-term monitoring at facilities like the one at Big Spring. It will take into account the results of the in-depth sampling conducted during this study, and develop a robust monitoring approach to reduce risk to public health while keeping costs low through the use of appropriate process monitoring and surrogate measurements.

A team led by Carollo was recently awarded a grant funded by the Texas Water Development Board (TWDB) to study the water quality delivered by the RWPF. This team is in the process of developing a testing protocol to demonstrate the water quality produced by RWPF. As part of this testing, state of the art online monitoring approaches and surrogate testing are proposed to compliment analyses for pathogens (virus, protozoa, and bacteria) and trace pollutants (pharmaceuticals, endocrine disruptors, disinfection by products, flame retardants, perfluorinated compounds, and others).

The current study provides a detailed review of system performance in accordance with public health and Texas Commission on Environmental Quality (TCEQ) regulatory objectives. The additional funding from WRRF for this TC project allows a substantial expansion of project scope and value. This additional sampling and laboratory work would be done concurrent with funded efforts. This additional research will increase the breadth and statistical accuracy of the data set, which is necessary for this research to have national recognition.

Project Update: This project was accepted as part of the Tailored Collaboration Program in May 2014. A PAC is being formed and the project is expected to begin August 1, 2014.

18. WRRF-14-12, Failsafe Potable Reuse Project at the City of San Diego's Advanced Water Purification Demonstration Facility (Contractor: Trussell Technologies)

This project will develop and examine a conceptual framework for a direct potable reuse facility for the California Department of Public Health (CDPH) at the City of San Diego's newly upgraded Advanced Water Purification Demonstration Facility (AWPF). It is envisioned that the conceptual framework will address issues beyond the treatment plant, such as source control, required operator training and certification, product water delivery and mixing strategies/requirements, as well as a plan to provide an alternative potable water supply in emergency scenarios and to ensure that extreme events do not compromise public health. There could be other necessary components of this framework that have yet to be defined. However, these aspects of the framework are not the focus of the specific testing program of the project, which will focus on demonstrating that a proper combination of today's established treatment technologies and on-line monitors are capable of providing the backbone of a reliable potable reuse project. The AWPF treatment plant has been modified to incorporate redundancy, both in treatment processes and on-line monitors; so that it can be ensured that adequate barriers are always in place to protect public health. The AWPF also incorporates a robust treatment train with diverse processes that are able to address various contaminants at varying concentrations. The demonstration facility will be evaluated in a manner that aims to demonstrate that the environmental buffer used in today's potable reuse projects in California can be eliminated. The project will be highlighted by an expert panel workshop that will consider the knowledge base developed by the WateReuse Research Foundation to date in outlining specific guidelines that will better define the needs of a direct potable reuse facility. Per Senate Bill 918, the CDPH must report on the feasibility of direct potable reuse by the end of 2016 and a National Water Research Institute (NWRI) expert panel has been contracted with the State of California to, among many other things, evaluate the feasibility of direct potable reuse. The primary

goal of this project is to inform the panel discussion and engage the CDPH in concepts that will encourage direct potable reuse.

Project Update: This project should start fall 2014 after successful contract negotiation between SDCWA, City of San Diego, WRRF, and Trussell.

19. WRA-14-01, Developing Direct Potable Reuse Guidelines (Contractor: NWRI)

Project Duration:

- Project Start – April 2014
- Draft Report Due – November 2014
- Estimated Publication Date – December 2014

The project will develop a White Paper with the purpose of identifying topics and issues that need to be addressed in the development of future national potable reuse guidelines. Guidelines for potable reuse would focus on issues such as public health protection, sufficient multiple barriers, risk assessment, water quality monitoring, and operation management. At present, six U.S. states (i.e., California, Texas, New Mexico, Oregon, Florida, and Arizona) have standards and/or guidelines for potable reuse under development, while many more are interested in receiving guidance. Federal guidelines on potable reuse do not currently exist and are not expected to be forthcoming.

This White Paper will be developed by an Expert Panel conducted by NWRI. The panel will meet several times to develop a comprehensive source of information and expert judgment on DPR, eview current state standards and guidelines efforts, and review decision factors and public protection goals for DPR. The first expert panel meeting is expected to occur in August. In June, a conference call was conducted with the PAC, the Panel Chair (George Tchobanoglous), Joe Cotruvo (Panel member), and Jeff Mosher of NWRI.

ITEM 4:

CALIFORNIA DIRECT POTABLE REUSE INITIATIVE RESPONSE TO JUNE 12, 2014 EXPERT PANEL REPORT (DATED JULY 21, 2014), PREPARED BY WRRF AND WATEREUSE CALIFORNIA



California Direct Potable Reuse Initiative Response to June 12, 2014 Expert Panel Report

July 21, 2014

WATEREUSE RESEARCH

WATEREUSE CALIFORNIA

WRRF is grateful for the CDPH Expert Panel Final Report dated June 12, 2014 responding to the March 5 conference call where the WRRF presented on our DPR research portfolio. WRRF appreciates the comments and input on our existing research and identification of added research opportunities. The purpose of this document is to respond to the Comments Section (3), outlining where WRRF existing research will support Expert Panel comments and where added research opportunities may lie. WRRF will assemble our Research Advisory Committee (RAC) on September 6, 2014 to expand our 2014 DPR program in response to this June 12 Expert Panel report.

3. COMMENTS

3.1 General Comments

- The Panel would like to receive copies of reports completed by WRRF on DPR-related topics (PDF files are preferred, when possible).

  We will provide this on our dropbox page: Click here to view DPR Folder. *Currently the following final reports are available:*
  - *Utilization of HACCP Approach for Evaluating Integrity of Treatment Barriers for Reuse (WRRF-09-03)*
  - *Demonstrating the Benefits of Engineered Direct versus Unintended Indirect Potable Reuse Systems (WRRF-11-05)*
  - *Evaluation of Risk Reduction Principles for Direct Potable Reuse (WRRF-11-10)*

- The Panel would also like to receive a copy of Policy Memorandum 97-005 on "extremely impaired water sources" (as mentioned by Bob Hultquist of CDPH).

- The Panel encourages the development of a website to provide the Panel with useful presentations and deliverables.
  - *Currently the Foundation shares material through dropbox*: Click here to view DPR Folder

- The Panel noted that the formal reports from newly awarded and future research projects may not be available in time to be useful toward the Panel review process; yet, in many cases, significant work may be completed or underway. The Panel is interested in finding an effective way to include an up-to-date understanding of this ongoing research in its deliberations. The Panel discussed receiving periodic updates, early materials, or presentations at future Panel meetings.
  - *We will provide quarterly updates on our DPR projects, providing a paragraph update on each. Quarterly progress reports and other important documents (scope of work, presentations, workshop summaries, etc) are located on dropbox if more information is desired. If there are specific questions, please direct them to Julie Minton. Also we'd like to have an opportunity for our PIs to present at Expert Panel meetings to provide more information on their WRRF project.*

- The Panel would like to receive information regarding out-of-spec behavior reported for IPR projects and drinking water treatment plants throughout the State. The Panel is particularly interested in incidences of compromise in the removal of pathogens, including the process used to discover breakthrough (if any). Such information could be provided in the form of a summary or in the form of case studies that include information like the process train used, type of incident or compound, response and response time, information provided to the public, public reaction, overall costs, and other relevant factors (such as risk factors, detection methods, potential surrogates, response measures, public outreach, and so on). Where IPR projects are specifically concerned, an example might be the Orange County Water District's response to the occurrence of N-Nitrosodimethylamine (NDMA), 1,4-dioxane, tritium, and acetone.
    - *WRRF-13-03 and 13-13 are not surveying out of spec results, but rather investigating the operational response and developing robust procedures to manage it.*
    - *WRRF-12-06 is looking at statistical variation in water quality from IPR facilities; findings will be shared once they come.*

- The Panel notes that peer-reviewed publications have greater credibility than industry research reports and encourages WRRF and its principal investigators (PIs) to consider producing peer-reviewed publications.
    - *We have encouraged our PIs to submit peer-reviewed publications.*

3.2 CDPH Mandate and Panel Process

- The Panel would like clarification of certain terms, which appear to be key elements of the State's mandate, including: "adequately protective of public health," "feasibility," "acceptable risk," and "DPR." The Panel would like to address these issues in detail at the next meeting, and would appreciate a presentation from CDPH discussing their perspective.
    - *WRRF would be happy to support this effort.*

- Regarding surface water augmentation criteria, the Occoquan Reservoir Project operated by UOSA in Virginia and the Lake Lanier Project operated by the F. Wayne Hill Water Resources Center near Atlanta, Georgia, are other projects of interest. Information on the status of DPR projects elsewhere, particularly Windhoek, Namibia, and Big Spring, Texas, would also be useful to the Panel. The Panel would like to hear a presentation addressing these projects.
    - *A project has been added to our DPR portfolio, 'Enhanced Pathogen and Pollutant Monitoring of the Colorado River Municipal Water District Raw Water Production Facility at Big Spring Texas' (WRRF-14-10), led by Eva Steinle-Darling at Carollo. We can arrange a presentation on this work as early as September when the first round of testing is complete (WebEx or in Dallas at WRA Symposium?).*

- As the Panel understands it, the purpose of the Advisory Committee is to provide insight and support to the Panel. To facilitate productive interaction, the Panel recommends that

a liaison from the Advisory Committee, such as the Committee Chair, be invited to attend the public portions of future Panel meetings. A direct dialogue between the Panel and the Advisory Committee may also prove useful in the future.

3.3 Comments about the Research Plan

The Panel would like to commend WRRF and WateReuse California for their efforts with the DPR Initiative. Overall, the research plan is comprehensive and thorough, especially in regards to addressing regulatory and utility concerns about DPR. The results of these research projects are highly anticipated.

3.3.1 General

- The feasibility of DPR depends, in part, on how it fits with other alternatives to expand the State's water resources through recycling of municipal wastewater effluents.
    - *WRRF-14-03*

- It is not clear to everyone that DPR must be pursued to meet the State's water resource needs. The Panel requests a review of the data that provide the basis for a water resource economic case of DPR for the State of California.
    - *WRRF-14-08*

- Doing away with the environmental buffer in potable reuse projects may represent a significant change. River flow and movement through the ground are both effective in removing many contaminants from water.
    - *WRRF-12-06*

- Reaction times and processes involved in the environment may be quite different from those in conventional treatment processes. Environmental buffers do not just create a barrier, but they can also be an effective treatment process for some contaminants. This issue needs consideration when evaluating the feasibility of DPR.
    - *WRRF-12-06*

- A comparison of the long-term impacts on water resources is needed between a few large IPR plants that redirect water back into the overall California raw water supply versus a smaller number of DPR plants built across the state.
    - *A challenging endeavor - to be considered post implementation of DPR plants.*

3.3.2 Research on Pathogens

In potable reuse projects, as wastewater sources and finished drinking water become closer together (in either time or space), the concern about protection from momentary lapses in pathogen control becomes increasingly important.

- The Panel suggests that the following questions about pathogen control, as provided by CDPH, become the subject of a future study:

- Is the available monitoring (including perhaps of surrogates) sensitive and rapid enough to tell us when the organism reduction goal is not being met?
    - *WRRF-11-01, 14-01, 12-06*
- How do we quantify the overall reliability of the treatment scheme?
    - *WRRF-11-01, 11-02, 12-06, 13-03, WRF 4508*
- How consistently must the treatment meet the organism log-reduction goal?
    - *WRRF-14-02*
- 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?
    - *WRRF-13-03*
- Are there Critical Control Points for key pathogens that can be identified and monitored?
    - *WRRF-13-03*

- Information on pathogen levels in raw wastewater is limited. Industry surveys should be conducted using peer-reviewed methods and techniques to characterize the pathogen levels in raw sewage, in different populations, throughout the seasons, and during local episodes of illness. New technology that provides high throughput, multiple pathogen identification, detection of emerging pathogens, and/or better quantification may be valuable in achieving this objective.
    - *WRRF-14-02*
    - *Explore alternative to current CA model of credits starting at raw water (Texas approach is documented in WRRF-12-06)*
    - *University of Arizona has extensive data on pathogens in raw sewage (influent) and after treatment (affluent), including viruses. Current studies are evaluating treatment efficacy at a new 21st Century WWTP (Agua Nueva – commissioned in January 2013) (per Ian Pepper)*

- Research needs to be conducted to document and quantify the removal of pathogens in different biological wastewater treatment processes. In the absence of that research, many advanced water treatment plants will likely be built with more treatment than is needed to establish removal credits.
    - *WRRF-14-02*

- A better understanding of the microbial community that exists in advanced treated water is needed, and how a stable microbiological community can be maintained throughout the distribution system when DPR is employed. It is important to ensure that new ecological niches are not being created for the proliferation of opportunistic pathogens. Emerging methods for measuring, monitoring, and managing the microbial community during storage and distribution of recycled water should be evaluated.
    - *WRF Project 4536 (Blending project) is exploring post treatment microbiological issues, including corrosion, antibiotic resistance, and opportunistic pathogen work*
    - *University of Arizona is planning to do next generation sequencing on sewage as it is treated (per Ian Pepper)*

3.3.3 Research to Address Regulatory Concerns

Other key differences between IPR and DPR are the consequences of process failures. Therefore, both failure analysis and reliability analysis will be important.

- There is a need to define and describe the concept of "safe." The word "safe" has different meanings to members of the community than it does to engineers who design facilities. Regulators often end up in the middle, making judgments about what is safe. The Panel sees the potential for a research project on better defining, communicating, and describing the concept of "safe." Will an annual risk of infection of 10^{-4} for potable water (for example, for pathogens) be the goal or are more safety factors necessary?
    - *WRRF-11-02 placed much effort into defining the treatment necessary to protect public health. "Safe" might be better replaced with "protective of public health".*
    - *"The Panel sees the potential for a research project on better defining, communicating, and describing the concept of "safe." – communication to public: WRRF-13-02*
    - *WRF 4508*

- Regardless of how effective, reliable, robust, redundant, and resilient the system is, we should be prepared for circumstances where it fails. Certainly, every precaution should be taken to prevent failure, but work is needed on what should be done in light of failure when it does occur (e.g., how to identify it, how will we respond to it, and how it will be communicated?). Simply put, this consideration needs to be more explicitly addressed in the research.
    - *WRRF-11-10*
    - *Communication: WRRF-13-02 Phase II - In the recommendations for Phase II of WRRF 13-02 the team has recommended a state level Rapid Response Plan that addresses what happens if there is a technical failure, or reported illness and what would be the communications process for informing media and the public.*
    - *WRRF-13-03 and 13-13*

- The concept of "resilience" has not been formally developed in potable reuse. Indications are this will be addressed by additional redundancy (e.g., log removals) in the treatment system to mitigate the effects of system failures. A rational basis is needed for determining how much redundancy is required, or systems will be predictably over-engineered with attendant costs in terms of redundant or substitute unit processes and space within a treatment plant to accommodate redundant systems. Therefore, a methodology based upon experience with the failure of unit processes in potable reuse system needs to be developed. There is a wealth of experience with the unit processes used in IPR (which are, for the most part, identical with those anticipated for use in DPR). If sufficient data are available from this experience, it should be straightforward to collect the data and develop a generic model (i.e., one that can be adapted to any given treatment train) for use in assessing the actual need for redundant treatment systems to maintain the accepted risk reduction goals through failures of different extents, durations, and severity. If the data are not available, it can be generated. Although likely more important for microbial agents, such a model should be useful for defining the flexibility

of treatment processes to remove specific compounds of proven health concern. In both cases, it should be possible to determine the response time for bringing redundant treatment online in the case of failures. Some problems will be small enough to address by taking the malfunctioning component offline, while others may require shutting down a significant fraction of unit processes required for a particular treatment. Whatever the degree of treatment failure that entails should include documentation of critical questions relating to the degree of impairment and variation in time required to make appropriate repairs, as well as the extent to which key components of established health concern in a particular water source are not being removed. This will allow a clear documentation of the extent to which public health protection may be diminished during failures in the treatment process that are inevitable. The impacts on risk are likely to be minimal for documentable health risks, and are unlikely to be remedied by arbitrarily increasing the assignment of additional logs of removal to a treatment train.

- *We recognize the importance of this work, and much of our existing research will touch on this (WRRF-11-02, 11-10, 12-06, 13-09 Indirect Potable Reuse Investigation in Tucson, AZ, 14-03 and 14-08 cost analysis)*
- *The Australian Water Recycling Centre of Excellent (AWRCoE) is working on a resilience model of IPR/reuse plants which would be valuable information also. The WRRF-13-03 team is working to bring this into that project.*
- *WRRF-14-12 (San Diego demo) will illustrate full concept of resilience*
- ***Exploratory project**: Additional research may be needed and several opportunities are broached here to be explored at RAC meeting in September.*
  - *Evaluate different components of train and independence of unit processes – what happens when one fails? Are they truly independent and is process resilient?*

- A key component of defining the "consistency of treatment" is to understand the variability that occurs within each unit process in a treatment train and incorporate this variability into a quality assurance analysis. The WRRF 13-03 Project on "Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme" is expected to compile data from actual facilities on the variability of an entire treatment train. The Panel would like to receive more information about this new project, including the experimental plan.
  - *WRRF-13-03- dropbox includes scope of work and PRs. The team would be happy to present project plan via a WebEx or at next meeting.*
  - *WRF 4508*

- At present, as an industry, we do not understand what makes a barrier redundant or independent. It is a research need. Full-scale monitoring should assess what makes it redundant for contaminants of interest.
  - *This fits with **Exploratory project** above.*
  - *WRRF-11-02, 14-12 (San Diego demo)*

- What treatment trains are considered equivalent to full advanced treatment (FAT)? It is unclear to the Panel if other treatment trains are being considered by CDPH or if FAT is

the gold standard. Also, what types of scale should these schemes have (e.g., oversight, financial, etc.)?
    - *Two trains in WRRF-11-02, 13-03*

- The Panel suggests examining the experiences of the food industry.
    - *WRRF-11-10 examines other industry (structural and aviation), WRRF-13-03 HACCP concept originated in food industry*

- A more thorough evaluation may be warranted of the experiences of other DPR schemes (like Windhoek) and their response strategies. It may be useful to expand this effort to include surface water treatment plants using source water that receive a significant amount of wastewater discharge.
    - *WRRF-14-10*

3.3.4 Research to Address Utility Concerns

- A more comprehensive economic analysis of potable reuse is needed. This analysis should consider factors such as the drought-proof nature of potable reuse and benefits of a diversified water supply portfolio. Research may exist to help assess when DPR projects should be selected over traditional water supply projects.
    - *WRRF-14-03, 14-08*

- The Panel anticipates that issues pertaining to energy, such as costs, conservation, and recovery, may be adequately addressed in the upcoming WRRF 14-03 project titled "Developing Methodology of Comprehensive (Fiscal/Triple Bottom Line) Analysis of Alternative Water Supply Projects Compared to DPR." Keeping the Panel updated on the progress of this project will be helpful.
    - *WRRF-14-03*

- The Panel would like to see more information regarding requirements and the need for providing blending for DPR and surface water augmentation projects that might differ from CDPH's groundwater recharge draft regulations (i.e., source water used for blending, location of blending, accounting [the recycled water contribution concept averaged over several years]).
    - *WRF4536*

- The Panel would like more information regarding the potential of non-reverse osmosis (RO) treatment options being suggested to eliminate the need for brine disposal. RO removes a significant number of contaminants from water. Would DPR without RO eliminate an important barrier?
    - *WRRF-11-01, WRRF-13-10 Controlling Trace Organic Contaminants using Alternative, Non-FAT Technology for Indirect Potable Water Reuse*

3.3.5 Research to Address Community Concerns

The Panel would like to provide the following suggestions to broaden the "Community Concerns" portion of the DPR research effort, increase transparency, and address information gaps:

- We need to consider how other industries (like air travel, food processing, and nuclear power) have addressed questions about safety and confidence with the public. What systems have these industries created to ensure quality? Can we modify or apply them to DPR?
    - *This is an excellent idea but beyond the current scope of WRRF-13-02; this will be explored further.*

- It will be important to discuss openly with the public other water supply options that may be available besides DPR (e.g., IPR, desalination, tradeoffs with agricultural, etc.).
    - *WRRF-13-02*
- Selecting straightforward, transparent terminology to describe the DPR process is a step in the right direction. However, a more comprehensive plan is needed to address the concerns of opponents and community members who feel alienated; terminology alone will not be enough to lessen their fears.
    - *WRRF-12-06,*
    - *WRRF-13-02 explored this further in focus groups and telephone surveys in two model CA communities (SD & SCVWD). The results and findings and key messages will be in the final report later this year.*

- The composition, disposal, and environmental impacts of RO reject probably warrant further consideration as well.
    - *Seawater desal and DPR have some of the same challenges.*
    - *WRRF-13-10 Controlling Trace Organic Contaminants using Alternative, Non-FAT Technology for Indirect Potable Water Reuse for no-RO schemes*

- Some speak as if treated drinking water is sterile, whereas in reality, it contains varying concentrations of microorganisms, most of which are believed to be benign. This misperception will need to be addressed when communicating the safety of DPR projects to the public and stakeholders. The concept of the "water microbiome" may provide a means of understanding and communicating this idea
    - *WRF 4536*

- Clarification is needed as to how the products of the research to address community concerns will be used and by whom. For instance, will a rapid response team be necessary for DPR projects? In recent times, we have seen the emergence of pathogens and chemicals (e.g., *Giardia, Cryptosporidium, Legionella,* HIV, prions, emerging disinfection byproducts, etc.) that have been of concern to health professionals and the community. Some of these have been serious problems, while others have posed little, if any, risk to water supplies. Consideration should be given to developing a mechanism for addressing process treatment failures, community outbreaks of illness, newly

identified chemical contaminants and pathogens, and social issues in a timely manner. Developing this mechanism might require maintaining a list of on-call experts in a variety of fields, as well as deciding which agency or group should be responsible for coordinating the rapid response team.

- *WRRF-13-02 Phase II includes description and funding for developing a Rapid Response Plan that addresses what happens if there is a technical failure, or reported illness and what would be the communications process for informing media and the public.*

3.3.6 Health Research

More effort should be devoted to health research. Suggestions include:

- A first priority should be the design of study(s) to assess changes in infectious disease rates when DPR is initiated. An approach has been suggested by other NWRI Panels for various IPR projects. Generally, such studies should be set up with county or state health departments in areas where activities may be ongoing. Ongoing standard surveillance activities should be leveraged to establish baseline rates of illness (e.g., hospital visitations, emergency room visits, school absenteeism, and calls to nurse hotlines). The DPR system should not be the sole focus of investigation, but rather tied in with a broader surveillance of disease outbreaks in the area. It should also be integrated into these projects as one of the variables examined. A pilot project should be funded that investigates the feasibility of such an effort with the appropriate public health authorities in areas where DPR is likely to be initiated. It is important that actual studies be initiated prior to the introduction of DPR.
  - *We agree this work is important and would be open to discuss how we can support this work.*

- Efforts on diseases that might result from chemical exposure are also possible, but would require much more work in designing an approach. The key to how such studies can be conducted is the selection of appropriate health endpoints. This may mean some divergence from studying classical health endpoints, but focusing on biomarkers that are dependable indicators of increased risk for such endpoints
  - *WRRF-10-07*

- Public health surveillance is a key component of any IPR or DPR project and should be adequately addressed. During the City of San Diego Health Effects Study (c.1992), a baseline was developed on pertinent morbidity and mortality data so that a basis of comparison would be available to the City if potable reuse became a reality. The Panel can be provided relevant historical background work from San Diego, if needed. Also, taste and odor complaints should be tracked, monitored, and evaluated.
  - *We agree this work is important and would be open to discuss how we can support this work.*

3.3.7 Chemicals of Emerging Concern (CECs)

WRRF and WRF have done extensive research in CEC in reuse and drinking water, and we can share that work if desired.

- It appears that several of the proposed DPR Initiative projects imply that additional bio-analytical screening assays are needed for CECs. The DPR Initiative team should dialogue with staff from both the Southern California Coastal Water Research Project (SCCWRP) and San Francisco Estuary Institute (SFEI) regarding ongoing research in California involving the use of such assays for certain CECs. In addition, other organizations and agencies, such as the State Water Resources Control Board, are involved with research projects to evaluate bio-analytical tools. These outside efforts should be incorporated into the Panel's review process and DPR Initiative (for instance, include a presentation on the results of these projects at a future Panel meeting).
    - *WRRF-10-07 (included 2 collaborative workshops with SCCWRP on their similar project)*
    - *WRF 4508 will recommend appropriate analytical methods and testing for CEC's as part of a DPR monitoring framework*

- The Panel encourages the DPR Initiative team to read the brief review on antibiotics and antibiotic resistance in the April 2012 SCCWRP report on *Monitoring Strategy for Chemicals of Emerging Concern (CECs) in California Aquatic Ecosystems: Recommendations of a Science Advisory Panel* (see Section 4.3 and Appendix F of the report, which can be found on the SCCWRP website[1]).
    - *We are supporting WERF lead project: Occurrence, Proliferation and Persistence of Antibiotics and Antibiotic Resistance during Wastewater Treatment*
    - *WRF 4536 will include testing for antibiotic resistance*

3.3.8 Hazard Analysis and Critical Control Points (HACCP)

The Hazard Analysis and Critical Control Points (HACCP) framework deserves consideration. As follow up:

- The Panel would like to receive more information about the ongoing WRRF 13-03 Project on "Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of DPR Scheme." It is understood that the project is in the early stages and the first progress report is pending. In the meantime, the Panel would find it helpful to receive the experimental plan for WRRF 13-03.
    - *WRRF-13-03*

- Though some Panel members have concerns about validation and calibration, the Panel is also interested in the workshop results for the WateReuse-10-07 Project on "Bio-Analytical Techniques to Assess the Potential Human Health Impacts of Reclaimed Water."
    - *WRRF-10-07*

[1] http://www.sccwrp.org/ResearchAreas/Contaminants/ContaminantsOfEmergingConcern/EcosystemsAdvisoryPanel.aspx

3.3.9 Application of Research

The Panel would like to learn more about the plan to transition the results from research to application. How will operators make the tools work? Will the tools be practical? Will the test results provide usable information (quality of information) that is a reliable guide to whether treatment needs to be improved (if possible) or water wasted? Can the results be interpreted or explained to the public?

- *We are aware of this need and how critical it is to implement the results. Where appropriate, teams develop non-traditional deliverables such as tools, guidelines, outreach materials, etc. to foster dissemination and usability. This will be a work in progress, and we encourage recommendations/collaboration to ensure success.*

1.4 Panel's Response to Research Plan Questions

1. ***Does the Research Plan appropriately define the needed DPR research?***

   The Panel believes that the DPR Research Plan is comprehensive and thorough, especially in regards to addressing regulatory and utility concerns about DPR. The results of the research projects will assist in providing regulators and utilities with the information they may need as they consider implementing DPR. The comments provided in this Panel Report are intended to help strengthen the Research Plan.

2. ***Is the framework presented in the Plan appropriate (i.e., regulatory, utility, and community concerns)?***

   The Panel believes that the framework summarized in the DPR Research Plan for addressing regulatory, utility, and community concerns is suitable for the intended purpose. The Panel provided additional comments in this Panel Report on areas in the Research Plan that may need to be strengthened, such as focusing on health research.

3. ***Can the Panel identify any substantial gaps in the research framework, including the current research and proposed future research?***

   In the time allotted for the current review, the Panel was unable to conduct a comprehensive analysis of gaps in the proposed research framework or list of current and future projects. The comments above provide a preliminary assessment of gaps and suggestions for additional research. The Panel suggests that the status of current research efforts be reviewed at Panel meetings with research organizations to maintain a dialogue on current and future research efforts.

4. ***Does the Panel have other comments for WRRF and WateReuse California as it implements the Plan?***

   In addition to the comments provided in this Panel report, the Panel would like to learn more about the plan to transition the results from research to application. How will

utilities make use of the results and tools? The interpretation indicators and surrogates (either as water parameters or as indicators of health risk) must be specified, justified, and validated. Prioritization is also of interest. What should be done first? Why? And how? Pilot and field studies are an essential component of translational science for the water industry, and that type of follow up might be needed.
Work in progress – conversation to be continued.

5. ***How would the Panel like to be updated in the future on the status of the research efforts?***

The Panel would benefit from updates on current or upcoming research efforts, including early materials (as discussed in Section 3.1 of this report). Perhaps there could be a briefing or summary of the conference call meetings held between WRRF and its project PIs for the DPR Initiative.
Presentation and important project material will be in dropbox.

ITEM 5:

DRAFT DDW ADVISORY COMMITTEE FOR EXPERT PANEL ON DIRECT POTABLE REUSE MINUTES OF MEETING NO. 2 (DATED JULY 11, 2014), PREPARED BY DDW ADVISORY COMMITTEE

MINUTES OF MEETING NO. 2
State Water Resources Control Board Division of Drinking Water
Advisory Committee for Expert Panel on Direct Potable Reuse
July 11, 2014

Chair Garry Brown called to order the second meeting of the Advisory Committee for the Expert Panel on Direct Potable Reuse (DPR), held on behalf of the State Water Resources Control Board Division of Drinking Water (DDW), at 10:00 a.m. in the Board Room of the Orange County Water District of Fountain Valley, California.

Advisory Committee Members Present
Garry Brown, Chair, Orange County Coastkeeper
Randy Barnard, Division of Drinking Water
Mark Bartson, Division of Drinking Water
Conner Everts, Environmental Justice Coalition for Water
Al Lau, Padre Dam Municipal Water District
Traci Minamide, City of Los Angeles, Bureau of Sanitation
Alisa Reinhardt, San Diego Regional Chamber of Commerce
Keith Solar, San Diego County Taxpayers Association
Frances Spivy-Weber, California State Water Resources Control Board
Roy Tremblay, County Sanitation Districts of Los Angeles County
Andria Ventura, Clean Water Action
Mike Wehner, Orange County Water District

Advisory Committee Members Absent
Jim Fielder, Santa Clara Valley Water District
Bruce Macler, U.S. Environmental Protection Agency
Charles Mosher, Mariposa County Health Department
Marsi Steirer, City of San Diego

Others Present
Brian Bernados, Division of Drinking Water
Peter Brooks, Xylem
Evelyn Cortez-Davis, Los Angeles Department of Water and Power
Trevor Currie, Los Angeles Department of Water and Power
Christopher Gobelich, Metropolitan Water District of Southern California
Cathy Green, Orange County Water District
Peter Green, Resident
Dawn Guendert, GHD
Bob Hultquist, Division of Drinking Water
Ken Ishida, Orange County Water District
Al Javeir, Eastern Municipal Water District
Jayne Joy, Eastern Municipal Water District
Maria Mariscal, San Diego County Water Authority

Peter Martin, City of San Diego
Larry McKenney, Santa Ana Watershed Project
Jeff Mosher, National Water Research Institute
Brian Olney, Helix Water District
Jeff Pasek, City of San Diego
Toby Roy, San Diego County Water Authority
Joe R. Silva, Chemical Engineer
Gina Vartanian, National Water Research Institute

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1. WELCOME AND INTRODUCTIONS

Mark Bartson of DDW noted that the California Department of Public Health's Drinking Water Program was officially transferred to the State Water Resources Control Board (SWRCB) and renamed as the Division of Drinking Water (DDW) on July 1, 2014.

Mark Bartson would like to replace his position on the Advisory Committee with Randy Barnard, P.E., of DDW. Bartson will still attend all the Advisory Committee meetings. The Committee is supportive of their efforts and agreed to this change.

2. REVIEW OF AGENDA

Information item. No motion needed.

3. MINUTES

The minutes of the first Advisory Committee Meeting, held on February 21, 2014, was presented to the committee. A motion was made to approve the minutes. The motion was seconded and approved unanimously.

Committee Member Conner Everts noted that he is Chair of the Board (and not the Executive Director) of the Environmental Justice Coalition of Water, as reported in the minutes.

4. PRESENTATION ON DDW EXPERT PANEL ACTIVITIES

Jeff Mosher of the National Water Research Institute, which manages the DDW Expert Panel, provided an update of activities undertaken by the Panel since February 21, 2014. This update included a brief presentation of DPR activities in Texas and New Mexico, the California DPR Research Initiative undertaken by WateReuse Research Foundation and WateReuse California, and the following Panel activities: changes in Panel membership, Panel meeting held on March 5, 2014, and Panel meeting deliverable. Specifically:

Changes to Panel Membership: Rhodes Trussell resigned as Panel Chair effective June 6, 2014, and was replaced by Co-Chairs Jim Crook (a new Panel member) and Adam Olivieri on June 17, 2014. In addition, Joan Rose and Kara Nelson were added to the Panel to

strengthen its areas of expertise and diversity. A motion was made by Committee Member Mike Wehner to approve these Panel member changes. The motion was passed unanimously.

Panel Meeting: The Panel met by conference call on March 5, 2014, to (a) discuss the DDW mandate, (b) review the current version of the California DPR Initiative Research Plan and other current DPR Research activities, and (c) identify additional areas of research needed to establish criteria for DPR. This meeting was chaired by Rhodes Trussell and attended by all members of the Panel, including new members Joan Rose and Kara Nelson. Because Rhodes Trussell was still Chair, Jim Crook was not yet appointed to the Panel; thus, he did not participate in the meeting or the development of the meeting deliverable.

Panel Meeting Deliverable: Report of the March 5 Meeting: Jeff Mosher provided an in-depth discussion of the findings and recommendations of the Panel deliverable, which was a Panel report. It was noted in the report that the Panel did not have "significant time to deliberate the issues in DPR or develop consensus" and their "views may further evolve" over time.

Advisory Panel Comments and Questions:

<u>DPR Projects in Texas and New Mexico:</u>

- Garry Brown: What is the timeframe from leaving the treatment plant to going to the water treatment plant?
    - Response: It is on the order of hours. In Big Spring, the time is in the pipeline (i.e., hours), while Wichita Falls may have less time because it is a smaller system.
- Andria Ventura: Where did the Village of Cloudcroft get the money for their DPR project?
    - Response: The State of New Mexico offers grants to small systems to build water supply projects. But a question that came up is whether the community has money to operate the system on a daily basis. Our NWRI Panel is reviewing that very issue.

<u>CDPH Mandate and Panel Process:</u>

- Mike Wehner: Can the Co-Chairs of the Expert Panel participate at the Advisory Committee meetings?
    - Response: The question will be raised with the Expert Panel.

<u>Comments on Research Plan (Regulatory Concerns):</u>

- Garry Brown: Does the Expert Panel realize that most of these questions they ask regarding research don't have existing answers? They could be adding to the mix of questions rather than getting answers.
- Andria Ventura: I'd like to hear a presentation from the researchers as to what terms like "safe" mean in relation to the work they are doing.

Comments on Research Plan (Health research):

- Brian Bernados: Was the Panel recommending a water research project on infectious disease rates or was it a general comment?
    - Response: It was more of a general comment. The Panel did not indicate at this time that this work should be done.

Comments on WRRF Research Activities:

- Frances Spivy-Weber: When will WRRF provide responses back to the Expert Panel?
    - Jeff Mosher: They will give the Expert Panel report to the DPR subcommittee of WRRF research advisory committee in September. Jeff has been invited to attend this meeting. Projects are approved annually.
- Ray Tremblay: Did the Expert Panel go through in detail the scope of work for each WRRF project?
    - Jeff Mosher: They were given a lot of information, but most knew about many of these projects already.
- Frances Spivy-Weber: What effort is being made to get information on projects undertaken outside of WRRF?
    - Jeff Mosher: There is much overlap among organizations, and we know a lot about what is happening.
    - Mike Wehner: Some work going on in the United Kingdom could be pulled into this project.
- Frances Spivy-Weber: The public will be interested in how broadly the research community has been brought in to the Expert Panel effort.
    - Jeff Mosher: Individual Panel members have the expertise and are on the frontlines of this research; they will be able to tell us where the research is.

Comments on Economic Analysis

- Frances Spivy-Weber: Where does the economic analysis fit in the priority system?
    - Jeff Mosher: WRRF will have to evaluate this further. They have a small effort looking at the triple bottom line (concept paper). They also have a multi-thousand dollar project on triple bottom line that will come out soon.
- Andria Ventura questions why the Expert Panel kept bringing economic issues to the conversation. Economics will vary from community to community; it will ultimately come down to policy decisions within each community. How general of an analysis can be done?
    - Jeff Mosher: Part of this effort is trying to get agencies to think about doing this economic analysis in more informative ways.
- Garry Brown: The Expert Panel is a technical panel. Who will we look to or what collaboration are we looking to create a complete package (i.e., policy, technical, economic, etc.)? It is WRRF or someone else?
    - Jeff Mosher: This is not in the Panel's specific charge. DDW has the role of developing the criteria. I think with its broad projects, WateReuse California is positioning itself to develop and package that information.

Comments on Peer-Review Publications

- Frances Spivy-Weber: It is costly and timely to get peer-reviewed documents out of research projects – but, it is a key element to get that peer review.
    - Mike Wehner: The formal peer review and publication processes are slow. Most of these projects will not be published until after the 2016 deadline.
    - Frances Spivy-Weber: The Expert Panel should identify those studies that should be peer-reviewed journal articles.

Comments Regarding Out-Of-Spec Behavior

- Mark Bartson: Is there a need to go deeper in capturing the out-of-spec information for the Expert Panel?
    - Brian Bernados: We compiled information from the six IPR projects in the state. But we have had limited response on issues with drinking water plants. Do we need to get information from drinking water plants throughout the US?
    - Jeff Mosher: We need to clarify what type of information the Expert Panel wants on out-of-spec behavior. We should put this on the agenda for the next meeting – talk about what was provided and get more direction from them.
    - Mark Bartson: It is important for operator training and certification. It is good information for that aspect, too.
    - Action item: NWRI to provide the out-of-spec material to the Advisory Panel.
- Andria Ventura: I'm pleased to see the questions brought up on failsafe, etc., but I'm not sure if it includes a system in which water and contaminants went through, but the actual contaminant did not get to the consumer.
    - Jeff Mosher: That is part of the review. We don't have all of the information yet.
    - Andria Ventura: Communities will be looking at the balance between how many barriers do you need vs. the costs of having so many barriers.
- Garry Brown: There is consensus that we don't have as good online technological monitoring before we implement DPR – is there better technology to detect any type of change post-treatment?
    - Jeff Mosher: Referred to GWRS and the results received from performance monitoring. But we don't have one monitoring scheme that tells us every constituent didn't get through.
    - Garry Brown: A balance is needed between monitoring for too many items and ending monitoring for items that were non-detect.
        - Jeff Mosher: We need meaningful monitoring for performance and other reasons.
- Mark Bartson: What is the best independent answer regarding comparing the safety of recycled water with drinking water systems?
    - Jeff Mosher: The NRC did this work and it suggests both recycled water and drinking water systems are safe and protect public health (see page 10 of the NRC "Water Reuse" report summary).
    - Mark Bartson: What other work may be needed in the future?
        - Jeff Mosher: The Panel is interested in surveillance.
- Andria Ventura: Research on chemical exposure and disease is very important. I would suggest we look at low dose impacts, which may be more serious than higher dose impacts. Also, in addressing community concerns, looking at other industries is not a bad

idea – but I am concerned with who they are suggesting (there is a difference between a public entity protecting public health vs. a corporation protecting their bottom line). NGOs and community-based organizations can offer help in this area (for instance, raw water having microbiomes will not mean anything to the public). The Advisory Committee should have future discussions on working/engaging with the public in a transparent way.

- Jeff Mosher: It would be useful to ask the Principal Investigator of WRRF Project 13-02 on "DPR Communications" to give a presentation to the Advisory Committee. We will contact WRRF for a presentation (perhaps at next meeting).
- Brian Bernados: One report was WRRF 11-10 on "risk reduction principals" that looked at other industries and how they deal with risk. That report is published and can be accessed publically.
- Randy Barnard: Is community communications beyond the scope of the Expert Panel?
    - Andria Ventura: It's not so much about us informing the Expert Panel, but it is something we as the Advisory Committee may be able to advise DDW in a way to be communicating to the public that makes sense to them.
- Garry Brown: I serve on a panel on the decommissioning of San Onofre Nuclear Generating Station. The goal is to communicate with the public and ask questions that the public would ask. It is a process that gives the public a forum to answer tough questions and engage the public. As we go forward with DPR, how do we communicate and how do we stage DPR?

5. COMMENTS AND DISCUSSION FOR EXPERT PANEL

- Garry Brown: How do we as a committee see the role of the Advisory Committee and what actions we can take to add to this process?
    - Mark Bartson: This group can help DDW with practical aspects, as well as communicating with the public.
    - Garry Brown: Need to better understand what WRRF and other groups are doing and how we can better communicate and/or collaborate with them. Also, communicating with the public is equal to the science, and is a major role of this Advisory Committee. Suggestion: The San Onofre decommissioning committee hired Senator Diane Feinstein's Chief of Staff; he would make a good presentation for us on how to communicate with the public.

- Mike Wehner: Are there other projects with WRRF that the Advisory Committee would benefit from hearing about beside WRRF 13-02?
    - Response: WRRF 11-02 treatment removal; WRRF 11-10 on risk; and/or WRRF 13-13 on training/certification project and OMMP plan.

- Frances Spivy-Weber: The Committee would benefit from hearing about the out-of-spec incidences compiled by CDPH.
    - Action: NWRI can send this material to the Committee.

- Conner Evert: It's good we are meeting at OCWD, an agency that has a great relationship with the public. There is much to learn from their IPR project.
    - Conner Evert: Our outreach role is key. Outreach should be started long before we run out of water.

- Ray Tremblay: Our role may include looking at the feasibility of undertaking a project. At this point, there is no list of what conservation, energy, etc. are going to cost for a project. This information will factor in when DDW develops the criteria.
    - Traci Minamide: You are talking about a case study. I am interested in the triple bottom line study. We should look at the competing interest of reusing water for potable reuse demand as opposed as that water no longer being around to go back in the environment and supporting the ecosystem.
    - Frances Spivy-Weber: What are the impacts associated with changes in water quality (e.g., sewage) that comes from activities like conservation?
    - Garry Brown: What can we do as a Committee regarding the triple bottom line research?
        - Jeff Mosher: Rob Raucher and George Tchobanoglous are co-authoring a paper on triple bottom line that may be available this year. The larger WRRF project is not going to get started until next year. Let's see what the paper looks like.

- Andria Ventura: Should this Committee produce deliverables like white papers on issues like the balance between recycling wastewater vs. not distributing it back to the environment? Or a white paper on communicating with the public?
    - Jeff Mosher: There are communities already thinking about these issues. LADWP is doing this type of work right now. Maybe Evelyn Cortez-Davis can describe what LADWP is going, SCVWD could describe what their outreach, or Al Lau can talk about Padre Dam's efforts.
    - Jeff Mosher: We could focus one meeting on discussing WRRF 13-02 and invite Ron Wildermuth to speak (he is a member of the Project Advisory Committee on WRRF 13-02).
    - Conner Everts: For these types of presentations, we should have an audience attend these meetings.
    - Garry Brown: Let's proceed with having a communications focus for the next Advisory Committee meeting.
    - Jeff Mosher: The subcommittee should meet to discuss the next Advisory Committee meeting agenda.
        - Add Keith Solar, Andria Ventura, Mike Wehner, and Traci Minamide to the subcommittee for next meeting

- Regarding appointing a liaison between the Expert Panel and Advisory Committee, it was recommended that the role of liaison not be limited to the Chair of the Advisory Committee. Different Advisory Committee members can be asked to attend various Expert Panel meetings.
    - The next Panel meeting will be held at OCWD and will focus mostly on surface water augmentation. It is not a public meeting, but observers may be invited.

Mike Wehner and Randy Barnard will both attend that meeting on behalf of the Advisory Committee. Mike Wehner will be asked to report back to the Advisory Committee. If any other Advisory Committee member would like to attend the meeting, please inform Jeff Mosher of your interest.

- The agenda for the next Advisory Committee meeting should be announced at the July 24-25 Expert Panel meeting. The Expert Panel should be notified of the topic of each Advisory Committee Meeting, should they like to attend.

6. FUTURE TOPICS AND WORK FOR ADVISORY COMMITTEE

- Jeff Mosher: We need the dates and locations of the next 2-3 meetings of both the Expert Panel and Advisory Committee meetings for planning purposes.
- Traci Minamide: Determine milestones for each meeting.
- Keith Solar: Are we alternating meetings with the Expert Panel?
    - Jeff Mosher: The Advisory Committee should meet first to better inform the Expert Panel. Also, the Advisory Committee may meet more frequently than the Expert Panel.
- Garry Brown: Set the themes and dates for the next three to four Advisory Committee meetings. Let's start structuring these meetings.
- Traci Minamide: Identify what we want the Expert Panel to do and tie that into the schedule of the research projects being undertaken.
- Garry Brown: Work backwards from the 2016 deadline and set milestones.
    - Jeff Mosher: NWRI will pull together a schedule and use the agenda subcommittee to help us. We can also get information from WRRF to get the project schedule.
- Andria Ventura: It's good that we are mixing up the geography of the Advisory Committee meetings (i.e., Sacramento and Orange County). Suggestion: Hold the next Advisory Committee meeting in the Bay area. Some of the Expert Panel members in the Bay area might attend the meeting. Use East Bay MUD or SCVWD as the hosting facility.
    - Mike Wehner: Jim Fiedler of SCVWD offered to use their facility.
    - Jeff Mosher: The Hyperion plant is a good location. Marsi Steirer would probably also suggest a meeting at the City of San Diego.
    - Mike Wehner: Suggestion: Hold the meeting on a Friday to help with the commute.
- Garry Brown: What is the frequency of meetings?
    - Jeff Mosher: The frequency would be based on number of topics you will cover in a certain timeframe.
    - Jeff Mosher: At the first Expert Panel meeting, we will discuss how the Panel will get their work done and the frequency of meetings needed to complete this work.
- Andria Ventura: If special topics come up, maybe we can hold a meeting using remote technology.
- Ray Tremblay: This group wants to be informed on a lot of subject matters. Meetings could be held quarterly or semi-annually. It depends on our charge.
    - Garry Brown: I think we should look at quarterly meetings and be flexible.
    - Mike Wehner: Defining the charge is up to DDW.

- Randy Barnard: DDW has to meet what the statutes require. We need to meet the statutes first, and then whatever information extra comes up is great.
- Jeff Mosher: NWRI will develop the meeting minutes and future potential topics, and we will review them with Garry Brown.

7. PUBLIC COMMENTS

Toby Roy of San Diego County Water Authority had the following comments:

- Suggestion: After each agenda item, please slate time for for public comments.
- Regarding public safety, risk, failure, and other issues, a body of knowledge already exists for IPR projects (e.g., there is a framework that defines what is "safe" in the Safe Drinking Water Act). Suggestion: Have the regulatory framework build upon what already exists to ensure consistency between IPR and DPR.

Jeff Pasek of the City of San Diego had the following comments:

- A number of reports, documents, and regulations were discussed today, but nobody knows or understands what is in all of them. Suggestion: Craft a compendium or field guide for potable reuse in California (e.g., a bibliography to use as a reference tool).
  - Ray Tremblay: Joe Cotruvo of Joseph Cotruvo & Associates had a project on collecting information on the regulatory framework across the nation.
    - Jeff Mosher: We can get that report.
  - Jeff Mosher: Published material is easy to compile, but "gray literature" is harder to gather. The WRRF 13-03 project is considering developing a website to compile much of this information.
  - Brian Bernados: DDW has developed a list of references for the Expert Panel to review, and we can share that information with the Advisory Committee.

8. AGENDA ITEMS FOR FUTURE MEETINGS

No additional items were identified.

9. FINAL DISCUSSION

None at this time.

10. ADJOURNMENT

There being no further business to come before the Advisory Committee, the meeting was adjourned at 1:30 p.m. on July 11, 2014.

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Garry Brown, Chair