NATIONAL WATER RESEARCH INSTITUTE

Final Panel Meeting Report #7: Direct Potable Reuse and Surface Water Augmentation

Based on an Expert Panel Meeting Held December 1-2, 2015
(Panel Meeting #7)

Prepared By:
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)

Prepared For:
State Water Resources Control Board Division of Drinking Water
(Agreement No. 13-21041)

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

ABOUT NWRI

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

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The Expert Panel (Panel) on "Development of Water Recycling Criteria for Indirect Potable Reuse through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse" was formed at the request of the Drinking Water Program of the California Department of Public Health (CDPH) in 2013.

The Drinking Water Program was officially transferred from CDPH to the State Water Resources Control Board (State Board) 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.

The Panel would like to thank State Board staff for the information, materials, and suggestions received from the State Board staff as part of this Panel Meeting. In particular, the Panel thanks Mr. Randy Barnard, Mr. Mark Bartson, Mr. Brian Bernados, Ms. Jing-Tying Chao, Ms. Karen Larson, and Ms. Sherly Rosilela of the State Board staff for their assistance.

In addition, the Panel thanks the National Water Research Institute for administering and organizing the Panel's efforts. Specifically, the Panel would like to thank Mr. Jeff Mosher for working with the Panel in the planning and facilitating the meetings and Ms. Brandi Caskey, Ms. Suzanne Faubl, Ms. Jaime Lumia, and Ms. Gina Vartanian for their support in organizing the meetings and preparing the meeting report. The Panel would also like to recognize the State Board's Direct Potable Reuse (DPR) Advisory Group for their input to the Panel.

DISCLAIMER

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

CONTENTS

ACRONYMS

CDPH	California Department of Public Health
CWC	California Water Code
DDW	State Water Resources Control Board Division of Drinking Water
DPR	Direct potable reuse
Panel	NWRI Expert Panel
IPR	Indirect potable reuse
NWRI	National Water Research Institute
State Board	State Water Resources Control Board
SWA	Surface water augmentation

1. PURPOSE OF THE REPORT

The purpose of this report is to provide the Division of Drinking Water (DDW) of the State Water Resources Control Board (State Board) with the Expert Panel's findings and recommendations on the topics discussed and information provided to the Panel at a meeting held on December 1-2, 2015 (Meeting #7). Specifically, the following topics were addressed:

A) Finalization of *Draft Final Panel Meeting Report #6: Surface Water Augmentation and Direct Potable Reuse (Based on an Expert Panel Meeting Held September 24, 2015)*, dated November 20, 2015.

B) Direct potable reuse (DPR):

- The seven topic-based DPR Briefing Papers being prepared by the Panel to address and fulfill its charge per the California Water Code (CWC).
- Upcoming presentation to the State Board on the Panel's activities related to DPR.
- Current efforts of the following groups to support and assist the Panel in fulfilling its charge:
    - State Board's DPR Advisory Group.
    - DPR Research Initiative (a collaboration led by the WateReuse Research Foundation).

C) Surface water augmentation (SWA) using recycled water:

- Current status of the State Board's draft regulations on "Surface Water Augmentation Using Recycled Water."
- Inquiry from the State Board as to whether to include an alternative section to allow for alternatives to the reservoir criteria in the draft regulations.

2. PURPOSE AND HISTORY OF THE EXPERT PANEL

In 2013, the National Water Research Institute (NWRI) of Fountain Valley, California, a 501c3 nonprofit, appointed state and national water industry experts to an independent, third-party Expert Panel to provide advice to the State of California on developing Water Recycling Criteria for indirect potable reuse (IPR) through surface water augmentation (SWA) and determining the feasibility of developing criteria for direct potable reuse (DPR).

The Panel was formed on behalf of the Drinking Water Program of the California Department of Public Health (CDPH). As of July 1, 2014, the Drinking Water Program was officially transferred from CDPH to the State Board and renamed as the Division of Drinking Water (DDW); therefore, hereafter, the State Board will be referred to in this report as the sponsor of the Expert Panel. This Panel for the State Board is administered by NWRI.

2.1 Expert Panel Charge

The specific purpose of the Panel is provided in Chapter 7.3 – entitled "Direct and Indirect Potable Reuse" – of the California Water Code[1]. The exact wording is as follows:

> 13565. (a) (1) On or before February 15, 2014, the department shall convene and administer an expert panel for purposes of advising the department on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation and investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse. The expert panel shall assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for direct potable reuse. The expert panel shall then recommend an approach for accomplishing any additional needed research regarding uniform criteria for direct potable reuse in a timely manner.

With respect to SWA, the Panel's charge – as stated in Section 13562 of the California Water Code (CWC) – is as follows:

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

[1] Appendix A contains a copy of Chapter 7.3 of the California Water Code, effective January 1, 2014. http://www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=13001-14000&file=13560-13569 (last accessed January 11, 2016).

With respect to DPR, the Panel is working with DDW to meet the following State-mandated deadlines, as required in Section 13563 of the CWC:

- On or before June 30, 2016, DDW shall prepare a draft report summarizing the recommendations of the Expert Panel.

- By September 1, 2016, DDW shall complete a public review draft of its report.

- On or before December 31, 2016, DDW is to provide a final report to the Legislature on the feasibility of developing uniform water recycling criteria for DPR.

Please refer to Chapter 7.3 of the CWC (in Appendix A) for a description of State Board and Panel activities as pertaining to this effort.

2.2 Expert Panel Members

The Panel is made up of 12 individuals who meet the requirement in Section 13565 of the California Water Code that the Panel "shall be comprised, at a minimum, of a toxicologist, an engineer licensed in the state with at least three years' experience in wastewater treatment, an engineer licensed in the state with at least three years' experience in treatment of drinking water supplies and knowledge of drinking water standards, an epidemiologist, a limnologist, a microbiologist, and a chemist."

Panel members include:

- *Panel Co-Chair:* Adam Olivieri, Dr.P.H., P.E., EOA, Inc. (Oakland, CA)
- *Panel Co-Chair:* James Crook, Ph.D., P.E., Environmental Engineering Consultant (Boston, MA)
- Michael Anderson, Ph.D., University of California, Riverside (Riverside, CA)
- Richard Bull, Ph.D., MoBull Consulting (Richland, WA)
- Dr.-Ing. Jörg E. Drewes, Technische Universität München (Munich, Germany)
- Charles Haas, Ph.D., Drexel University (Philadelphia, PA)
- Walter Jakubowski, M.S.., WaltJay Consulting (Spokane, WA)
- Perry McCarty, Sc.D., Stanford University (Stanford, CA)
- Kara Nelson, Ph.D., University of California, Berkeley (Berkeley, CA)
- Joan B. Rose, Ph.D., Michigan State University (East Lansing, MI)
- David Sedlak, Ph.D., University of California, Berkeley (Berkeley, CA)
- Tim Wade, Ph.D., United States Environmental Protection Agency (Durham, NC)

Background information about the NWRI Panel process can be found in Appendix B, and brief biographies of the Panel members can be found in Appendix C. More information about the Panel can also be found on the NWRI website at www.nwri-usa.org/ca-panel.htm.

3. DPR BRIEFING PAPERS

The Expert Panel will use a "Briefing Paper" approach to address and fulfill its charge, per the CWC, to investigate the feasibility of developing uniform water recycling criteria for DPR. The CWC states that the Panel "assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for DPR" and "recommend an approach for accomplishing any additional needed research" in a timely manner.

The DPR Briefing Papers will be authored by members of the Panel and reviewed and accepted by the overall Panel. Each paper will focus on one technical/scientific topic and address:

- Relevance to the Panel's charge.
- Pertinent available technical and/or research information.
- Overall Panel findings, conclusions, and recommendations (e.g., practical engineering and/or monitoring solutions, and research topics/approach).

The Panel will also compile and summarize key points from all the papers into a final Panel feasibility report that will include an Executive Summary.

3.1 DPR Briefing Paper Topics

The Panel selected seven key topics for the DPR Briefing Papers. A list of these topics, along with a short summary of potential report content, is provided below.

1. **Bioanalytical Tools (*In Vitro* Bioassays)** – Issues related to the use of *in vitro* bioassays for advanced treated wastewater (ATW) and drinking water.
2. **Quantifying Treatment Facility Reliability** – Description of multiple barriers (redundancy, inherent performance, and mechanical reliability); online monitoring tools (sensors, surrogates and indicators); and performance objectives (process and overall facility compliance).
3. **Analytical Methods/Tools** – Approaches for assessing chemical water quality in ATW and drinking water (with an emphasis on indicators and surrogates).
4. **Molecular and Other Pathogen Monitoring Methods** – Monitoring indicators, surrogates, and pathogens in ATW and drinking water.
5. **Antibiotic Resistant Bacteria and Antibiotic Resistant Genes in Water** – State-of-the-science, relative sources, potential exposure pathways, and relative significance of concern.
6. **Comparative Health Risks** – Associated with existing potable water supplies.
7. **Public Health Surveillance** – Example programs, ongoing national and state programs, health endpoints, sensitivity and interpretation of data, non-health based data, and feasibility of a DPR surveillance program.

3.2 Approach to Develop the DPR Briefing Papers

As mandated in the CWC, the State Board must prepare a draft report summarizing the recommendations of the Panel on or before June 30, 2016. To support the State Board in this effort, the Panel has identified tasks, deadline dates, and meeting dates to facilitate the development and completion of the DPR Briefing Papers. A summary is provided in Table 1 that includes the lead author, internal and/or external reviewers, timeline for the preparation of draft papers, and available Panel meeting dates in relation to the preparation and internal review of the DPR Briefing Papers.

Table 1: DPR Briefing Paper Topics, Leads, and Schedule

	Briefing Paper Topic	Panel Lead/ Other Authors*	Internal Draft Date	Panel Review Meeting Dates	Notes
1	Bioanalytical Tools (issues related to use in ATW and drinking water)	Richard Bull/ Kevin Crofton, Michael Dennison	Draft 2 weeks prior to Meeting #7; due date Nov 17, 2015 COMPLETED	Meeting #7 (Dec 1-2, 2015) COMPLETED	Intent is to finalize at Meeting #7 (Dec. 2015) FINAL DRAFT TO BE SUBMITTED FOR MEETING #8
2	Quantifying Treatment Facility Reliability (evaluation of multiple barriers and monitoring tools)	Charles Haas/ Jörg Drewes/ Perry McCarty/ Kara Nelson	Draft 2 weeks prior to Meeting; #7 due date Nov 17, 2015 OUTLINE REVIEWED 12/1	Meeting #7 (Dec 1-2, 2015) – draft only	Intent is to finalize at Meeting #8; DRAFT TO BE SUBMITTED FOR MEETING #8; SETUP WEB MEETING FOR LATE JAN 2016
3	Analytical Methods/Tools for Measuring Chemical Water Quality in ATW and drinking Water (emphasis on surrogates)	Davis Sedlak/ Jörg Drewes	Draft 2 weeks prior to Meeting #8 OUTLINE REVIEWED 12/1	Meeting #8 (Feb. 23-24, 2016)	DRAFT TO BE SUBMITTED FOR MEETING #8; SEDLAK CANNOT ATTEND MEETING
4	Molecular and Other Methods for Monitoring Pathogens in ATW and Drinking Water	Joan Rose/ Kara Nelson	Draft 2 weeks prior to Meeting #9	Meeting #9 (March 2016)	
5	Antibiotic Resistant Bacteria and Antibiotic Resistant Genes in ATW and Drinking Water	Walt Jakubowski/ Joan Rose/ Ryan Reinke/ Kellog Schwab/ Nick Ashbolt	Draft 2 weeks prior to Meeting #8; OUTLINE REVIEWED 12/1	Meeting #8 (Feb. 23-24, 2016)	DRAFT TO BE SUBMITTED FOR MEETING #8
6	Potential Health Risk Assessments Associated with Existing Potable Water Supplies Subject to Discharge from Municipal Wastewater, Stormwater, and Agricultural Runoff	Co-Chairs/ Brian Pecson/ Rhodes Trussell/ Charles Haas/ Michael Anderson	Draft 2 weeks prior to Meeting #10	Meeting #10 (April/May 2016)	Based on National Research Council Report/State Board additional data
7	Public Health Surveillance	Tim Wade/ Walt Jakubowski/ Michael Anderson	Draft 2 weeks prior to Meeting #11	Meeting #11 (June 2016)	Effort tied to WateReuse project #14-14
	DPR Panel Preliminary Findings	Co-Chairs		Meeting #11 (June 2016) – internal draft	Internal draft based on the results of Panel meeting and review of Briefing Papers – intend to send to State Board staff as a draft in July after internal Panel review

*Note: The first person listed for each topic is the lead author.
Table updated 12/9/2015

4. PANEL MEETING #7

A two-day meeting of the State Board's Expert Panel (Panel Meeting #7) was held on December 1-2, 2015, at the Irvine Marriott Hotel in Irvine, California. Although the specific focus of the meeting was on the development and review of the DPR Briefing Papers, time was devoted to discussing issues pertaining to the State Board's draft SWA regulations.

4.1 Panel Meeting #7 Background Material

Prior to Meeting #7, the following background material was provided to the Panel:

- *Draft Final Panel Meeting Report #6: Surface Water Augmentation and Direct Potable Reuse (Based on an Expert Panel Meeting Held September 24, 2015)*, prepared on November 20, 2015, by the Expert Panel on the Development of Water Recycling Criteria for Indirect Potable Reuse through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse.

- First draft of *DPR Briefing Paper #1: Bioanalytical Tools*, authored by R. Bull, K. Crofton, and M. Dennison and dated November 19, 2015.

- Material pertaining to *DPR Briefing Paper #2: Quantifying Treatment Facility Reliability*.
    - Brief write-up and proposed outline of Paper #2 (dated November 24, 2015).
    - List of possible assumptions for consideration when drafting Paper #2, prepared by P. McCarty.

- Proposed outline (with partial references) of *Paper #5: Antibiotic Resistant Genes and Antibiotic Resistant Bacteria in Water*, prepared by W. Jakubowski.

- Presentation slides on "Status of Expert Panel Efforts on Potable Reuse," prepared by A. Olivieri and J. Crook for the State Water Resources Control Board meeting to be held on December 15, 2015, in Sacramento, California.

- Presentation slides on "Status Report on WRRF 14-14: Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse," prepared by B. Pecson, S. Triolo, and S. Trussell.

- Letter written to A. Olivieri and J. Crook, Panel Co-Chairs, from Randy Barnard, State Board, on the subject of "Reservoir Criteria in the Proposed Surface Water Augmentation Regulations," dated November 16, 2015.

4.2 Panel Meeting #7 Agenda and Logistics

The Panel Co-Chairs and staff from NWRI and the State Board collaborated on the development of an agenda for Panel Meeting #7, which is included in Appendix D. The agenda was based on meeting the following specific objectives:

- Finalize Panel Meeting Report #6.
- Review the status of the DPR Briefing Papers, including:
    - Draft Briefing Paper #1 on Bioanalytical Tools.
    - Outline for Briefing Paper #2 on Reliability.
    - Schedule to develop the Briefing Papers.
- Discuss the status of the State Board's draft SWA regulations with DDW staff.
- Prepare for the December 15, 2015, presentation to the State Board.

On Day 1, the Panel met in a closed session to review and discuss (1) the various DPR Briefing Papers and (2) a principal component of a State Board DDW staff request to the Panel, via letter, as to whether it would be appropriate to include an alternative section in the SWA regulations that allows for alternatives to reservoir criteria.

On Day 2, the Panel met with the State Board DDW staff and the liaison to the DPR Advisory Group to review: (1) the Panel's current efforts to fulfill its charge as related to DPR; (2) other activities undertaken in support of the Panel; and (3) the presentation (including Expert Panel and Advisory Group member presentations) by State Board DDW staff on December 15, 2015, to State Board members. The Panel and State Board staff also discussed the status of the draft SWA regulations, including: (1) the alternative reservoir criteria letter from DDW; and (2) the internal peer review and schedule needed to finalize the regulations.

4.3 Panel Meeting #7 Attendees

All but two Panel members attended Meeting #7 in person. Drs. Wade and Rose were unable to travel to the meeting, but participated via a web-enabled conference call (Dr. Wade on both days, and Dr. Rose on Day 2). Other attendees included NWRI staff, State Board staff, and representatives from the DPR Advisory Group. A complete list of Panel meeting attendees is included in Appendix E.

5. SUMMARY OF PANEL COMMENTS AND RECOMMENDATIONS

The Expert Panel has organized its comments and recommendations – based on material presented at Meeting #7 – under the following topics:

- General Statements
- Finalization of Panel Report #6
- Direct Potable Reuse
- Surface Water Augmentation through Indirect Potable Reuse

These topic-based comments and recommendations are provided below.

5.1 General Statements

- The Panel appreciates the continued participation and interest of State Board staff in presenting at and attending the Panel meetings.

- The Panel will need both working days to review and discuss the DPR Briefing Papers at the next Panel meeting (Meeting #8, scheduled for February 23-24, 2016); therefore, Meeting #8 will only be open to Panel members and invited technical experts, as determined by the Panel.

- The Panel Co-Chairs have finalized their presentation slides for the State Board meeting to be held on December 15, 2015, in Sacramento, California.

5.2 Finalization of Panel Report #6

The Panel reviewed and provided comments on the *Draft Final Panel Meeting Report #6: Surface Water Augmentation and Direct Potable Reuse (Based on an Expert Panel Meeting Held September 24, 2015)*, prepared on November 20, 2015. The Panel comments were discussed and addressed, and the Panel finalized the report at Meeting #7.

5.3 Direct Potable Reuse

The following comments pertain to efforts and activities related to fulfilling the Panel's charge, per the CWC, to investigate the feasibility of developing uniform water recycling criteria for DPR.

5.3.1 Briefing Paper #1 on Bioanalytical Tools

Lead author Richard Bull provided a 26-page first draft of *DPR Briefing Paper #1: Bioanalytical Tools* (dated November 19, 2015). The Panel had the opportunity to review and provide comments on the draft, as well as received a presentation on the subject matter by Dr. Bull. This paper is expected to be finalized at Meeting #8.

- The Panel agreed that the purpose of this paper, and the question it is addressing, is whether *in vitro* bioassays should be used as a tool to monitor chemicals in advanced treated water.

- Based on the draft provided, the Panel identified the following as the three main draft conclusions:

    - Conclusion #1: While a battery of tests similar to ToxCast's could improve the "benchmarking" of waters of various types and treatment, this approach is not recommended for routine monitoring primarily because the data are not of a type that would allow for a valid assessment of the relative risks that could occur with humans exposures. In addition, per sample costs are high. The Expert Panel, therefore, has concluded that this approach is not feasible for routine monitoring.

    - Conclusion #2: Research has shown that high-throughput, single endpoint assays can be applied to testing water (nuclear receptor-activated reporter assays appear the most suitable); however, the challenge is in interpreting the data in terms of the risk of adverse health outcomes. Their use in routine monitoring should be considered analogous to the monitoring of specific chemicals with identified health risks and, even if not required, will assume that status through routine use. Thus, the Panel concludes that the use of bioassays for water quality monitoring requires a more thorough evaluation of the meaning attached to positive and negative bioassay results, especially if the intent is to monitor water intended for human consumption. It must be clear – qualitatively and from a dose-response standpoint – how bioassay results are linked to adverse outcomes. Before any bioassay is used in the field, guidance is needed as to how the results of each bioassay should be interpreted technically and in light of the specific application.

    - Conclusion #3: Over the last 40 years, bioassays have been used in water analysis for (1) screening for a particular biological activity, followed by subsequent identification of the active compounds with chemical analyses (screening and identification), and (2) sporadic use for water quality monitoring. The introduction of high-throughput bioassays in recent years has greatly expanded the ability to detect biological activities that might contribute to adverse health effects. There are some excellent examples of work of this type in the past, and some new efforts are appearing in the literature. The Panel concludes that the use of such methods as a means of discovering the nature of unidentified contaminants in source and finished water, and for the initial characterization of source waters, is appropriate. Thus, the Panel encourages the application of this approach as we proceed down the path towards DPR, but cautions that, at this time, these tools should be considered research projects and not for use in routine monitoring.

5.3.2 Briefing Paper #2 on Treatment Facility Reliability

A preliminary outline and other materials were provided by the working team for *DPR Briefing Paper #2: Quantifying Treatment Facility Reliability*. The Panel discussed assumptions to consider when drafting the paper and other factors relevant to this subject. A draft should be available for review at Meeting #8. The Panel discussed and agreed on the following assumptions:

- The criteria for DPR should be consistent with criteria for IPR in the protection of public health.

- The treatment facility reliability and constituent removal efficiency criteria accepted by DDW staff for IPR when relying on reverse osmosis (RO) and advanced oxidation processes (AOPs) are acceptable for DPR.

- The major need for DPR is to define what additional reliability criteria (e.g., treatment and/or monitoring) are needed to replace the functionality of the environmental buffer.

- The main focus is defining the feasibility of DPR criteria from a technical perspective.

Although the Panel agreed with these assumptions, the Panel requested that DDW provide a summary of the pathogen log removal credits allowed for various treatment processes, along with documentation for these allowances.

5.3.3 Briefing Paper #3 on Analytical Tools

Lead author David Sedlak provided a verbal list of items that will be covered in *DPR Briefing Paper #3: Analytical Methods and Tools for Measuring Chemical Quality in Advanced Treated Water and Drinking Water*. The emphasis of this paper is on indicators and surrogates. He stated that a draft should be available for review at Meeting #8.

- The Panel requests that the State Board DDW staff provide the Panel with a compilation of available advanced treatment plant monitoring on indicator chemicals/surrogate chemical monitoring (resulting from the Groundwater Recharge regulations).

- The Panel requested that State Board DDW staff provide an example of a completed Engineering Report (or at least the Table of Contents) from one of the approved groundwater recharge projects.

5.3.4 Briefing Paper #5 on Antibiotic-Resistant Genes and Antibiotic-Resistant Bacteria

Lead author Walt Jakubowski provided a proposed outline of *Paper #5: Antibiotic Resistant Genes and Antibiotic Resistant Bacteria in Water*. He confirmed that a draft would be available for review at Meeting #8.

5.3.5 Briefing Paper Format

Because Briefing Paper #1 was the first to be drafted as a complete paper and the first to be reviewed by the Panel, it was used as the basis for the Panel to discuss and agree upon a final format for all the Briefing Papers. As such, the Panel agreed to the following:

- Each Briefing Paper will serve as a chapter in the final Panel feasibility report on DPR.
- Preface material will be included in the final report and not in each individual Briefing Paper.
- A short abstract will be provided at the beginning of each Briefing Paper.
- Each Briefing Paper will include an introductory section that addresses the relevance of the paper, such as the exact purpose of the paper (i.e., the question being asked by the Panel), why the Panel has chosen to explore this issue, its expected value and/or application to DPR, and the approach the Panel will use to come to its conclusions and recommendations.
- The Panel will provide a clear conclusion (which will respond to the question asked in the introduction section).
- The conclusion section will also include findings and recommendations, as appropriate.
- Recommendations will be grouped together in subsections based on whether they address research needs, treatment plant operations and/or performance, and other areas of interest.
- Visuals (e.g., figures and diagrams) and call-out boxes will be incorporated into the Briefing Papers to enhance readability.

5.3.6 DPR Advisory Group

Per the CWC, the role of the DPR Advisory Group is to advise the Panel regarding the development of uniform water recycling criteria for DPR. A presentation was provided by Ray Tremblay, a member of the DPR Advisory Group, on its current activities.

- The Panel appreciates the participation of DPR Advisory Group representatives at the Panel meetings.
- The DPR Advisory Group is to be commended for taking the lead in addressing operator training and certification for advanced water treatment facilities. The Panel would like to review the White Paper on operator certification being prepared by the California Urban Water Agencies (CUWA) in collaboration with the DPR Advisory Group and other organizations.

- The DPR Advisory Group has also undertaken the development of a "potable reuse terminology" document that reflects the definition of key terms from both a regulatory and public relations standpoint. The Panel would like to receive an updated copy of these draft terms.

- The Panel recognizes that the DPR Advisory Group would like the opportunity to review both the DPR Briefing Papers and the Executive Summary listing key findings from the Briefing Papers. It should be noted that the schedule for developing the DPR Briefing Papers may not allow for sufficient time to conduct such a review; therefore, the Panel requests that Ray Tremblay continue to attend portions of the Panel meetings as the DPR Advisory Group liaison to understand the approach and progress made by the Panel on DPR and to report back to the full DPR Advisory Group.

5.4 Surface Water Augmentation through Indirect Potable Reuse

The following comments relate to completing the Panel's charge, per the CWC, to review the proposed SWA criteria and adopt a finding as to whether, in its expert opinion, the proposed criteria would adequately protect public health.

- The Panel discussed the State Board's letter in which the State Board requested a written response (at the Panel's discretion) to the following question: *In the Expert Panel's opinion, would it be appropriate to include an alternatives section in Article 9, thereby allowing alternatives to reservoir criteria that would be established in SWA regulations?*

    - At this point time, the Panel has not come to a substantive conclusion and has not released a written response. The topic will continue to be discussed among the Panel, with a response to be provided at some future date.

    - It should be noted that, through DPR Briefing Paper #2 on Reliability, the Panel will consider and most likely address the State Board's DDW staff follow-up questions on whether and how to distinguish IPR from DPR, and specific criteria for alternatives to the proposed SWA reservoir criteria.

- The Panel understands that the draft SWA criteria must undergo a scientific peer review process conducted by the State Board's Office of Planning, Research, and Performance. As part of this effort, the State Board must provide to the peer reviewers a written explanation of the scientific basis of elements of the criteria. If possible, the Panel would like to receive a copy of the peer review package, including this explanation.

- The Panel requests that the State Board's DDW staff provide the Panel with advanced notification of the dates and locations of any meetings or activities the State Board would like members of the Panel to participate in as part of finalizing the SWA regulations.

5.5 Follow-Up Activities Requested by the Panel

Within this report, the Panel has requested a number of follow-up activities by the State Board DDW staff and DPR Advisory Group. For ease of reference, the Panel has provided a list of these activities in Table 2.

Table 2: Follow-Up Activities Requested by the Expert Panel in Report #7

No.	Report Section	Topic Area	Follow-Up Activity Requested by the Panel
Requests for State Board DDW Staff			
1	5.3.2	DPR: Treatment Facility Reliability	Provide a summary of the pathogen log removal credits allowed for various treatment processes, along with documentation for these allowances.
2	5.3.3	DPR: Analytical Tools	Provide a compilation of available advanced treatment plant monitoring on indicator chemicals/surrogate chemical monitoring (resulting from the Groundwater Recharge regulations).
3	5.3.3	DPR: Analytical Tools	Provide an example of a completed Engineering Report (or at least the Table of Contents) from one of the approved groundwater recharge projects.
4	5.4	SWA: Internal Review	Provide a copy of the peer review package, including the written explanation of the scientific basis of elements of the SWA criteria, to be provided to scientific peer reviewers.
5	5.4	SWA: Panel Support	Provide advanced notification of the dates and locations of any meetings or activities the State Board would like members of the Expert Panel to participate in as part of finalizing the SWA regulations.
Requests for the DPR Advisory Group			
6	5.3.6	Operator Certification	Panel to review the White Paper on operator certification being prepared by CUWA in collaboration with the DPR Advisory Group and other organizations.
7	5.3.6	Terminology	Provide an updated copy of the draft potable reuse terminology under development by the DPR Advisory Group.
8	5.3.6	Participation at Panel Meetings	Continue to attend portions of the Expert Panel meetings to understand the approach and progress made by the Panel on DPR and to report back to the full DPR Advisory Group.

CALIFORNIA WATER CODE
CHAPTER 7.3 DIRECT AND INDIRECT POTABLE REUSE
SECTION 13560-13569

13560. The Legislature finds and declares the following:

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

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

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

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

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

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

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

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

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

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

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

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

(e) "Uniform water recycling criteria" has the same meaning as in Section 13521.

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

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

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

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

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

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

13562.5. Notwithstanding any other law, no later than June 30, 2014, the department shall adopt, by emergency regulations in accordance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, requirements for groundwater replenishment using recycled water. The adoption of these regulations is an emergency and shall be considered by the Office of Administrative Law as necessary for the immediate preservation of the public peace, health, safety, and general welfare. Notwithstanding Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, emergency regulations adopted by the department pursuant to this section shall not be subject to review by the Office of Administrative Law and shall remain in effect until revised by the department.

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

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

(3) The department shall provide a final report to the Legislature

by December 31, 2016. The department shall make the final report available to the public.

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

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

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

(3) Available information on health effects.

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

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

(6) Any other scientific or technical issues that may be necessary, including, but not limited to, the need for additional research.

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

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

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

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

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

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

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

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

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

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

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

(f) Water quality, limnology, and health risk assessments

associated with existing potable water supplies subject to discharges from municipal wastewater, stormwater, and agricultural runoff.

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

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

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

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

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

13565. (a) (1) On or before February 15, 2014, the department shall convene and administer an expert panel for purposes of advising the department on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation and investigation of the feasibility of developing uniform water recycling criteria for direct potable reuse. The expert panel shall assess what, if any, additional areas of research are needed to be able to establish uniform regulatory criteria for direct potable reuse. The expert panel shall then recommend an approach for accomplishing any additional needed research regarding uniform criteria for direct potable reuse in a timely manner.

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

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

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

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

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

Government Code).

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

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

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

(a) Recommendations from the expert panel appointed pursuant to subdivision (a) of Section 13565.

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

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

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

(e) Results of investigations pursuant to Section 13563.

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

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

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

APPENDIX B: Panel Background

About NWRI

For over 20 years, NWRI – a science-based 501c3 nonprofit located in Fountain Valley, California – has sponsored projects and programs to improve water quality, protect public health and the environment, and create safe, new sources of water. NWRI specializes in working with researchers across the country, such as laboratories at universities and water agencies, and are guided by a Research Advisory Board (representing national expertise in water, wastewater, and water reuse) and a six-member Board of Directors (representing water and wastewater agencies in Southern California).

Through NWRI's research program, NWRI supports multi-disciplinary research projects with partners and collaborators that pertain to treatment and monitoring, water quality assessment, knowledge management, and exploratory research. Altogether, NWRI's research program has produced over 300 publications and conference presentations.

NWRI also promotes better science and technology through extensive outreach and educational activities, which includes facilitating workshops and conferences and publishing White Papers, guidance manuals, and other informational material.

More information on NWRI can be found online at www.nwri-usa.org.

About NWRI Panels

NWRI also specializes in facilitating Independent Advisory Panels on behalf of water and wastewater utilities, as well as local, county, and state government agencies, to provide credible, objective review of scientific studies and projects in the water industry. NWRI Panels consist of academics, industry professionals, government representatives, and independent consultants who are experts in their fields.

The NWRI Panel process provides numerous benefits, including:

- Third-party review and evaluation.
- Scientific and technical advice by leading experts.
- Assistance with challenging scientific questions and regulatory requirements.
- Validation of proposed project objectives.
- Increased credibility with stakeholders and the public.
- Support of sound public-policy decisions.

NWRI has extensive experience in developing, coordinating, facilitating, and managing expert Panels. Efforts include:

- Selecting individuals with the appropriate expertise, background, credibility, and level of commitment to serve as Panel members.

- Facilitating hands-on Panel meetings held at the project's site or location.
- Providing written report(s) prepared by the Panel that focus on findings and comments of various technical, scientific, and public health aspects of the project or study.

Over the past 5 years, NWRI has coordinated the efforts of over 20 Panels for water and wastewater utilities, city and state agencies, and consulting firms. Many of these Panels have dealt with projects or policies involving groundwater replenishment and potable (indirect and direct) reuse. Specifically, these Panels have provided peer review of a wide range of scientific and technical areas related water quality and monitoring, constituents of emerging concern, treatment technologies and operations, public health, hydrogeology, water reuse criteria and regulatory requirements, and outreach, among others.

More information about the NWRI Independent Advisory Panel Program can be found on the NWRI website at http://nwri-usa.org/Panels.htm.

APPENDIX C: Expert Panel Member Biographies

Adam Olivieri, Dr.PH, P.E. (Panel Co-Chair)
Vice President
EOA Inc. (Oakland, CA)

Adam Olivieri has 35 years of experience in the technical and regulatory aspects of water recycling, groundwater contamination by hazardous materials, water quality and public health risk assessments, water quality planning, wastewater facility planning, urban runoff management, and on-site waste treatment systems. He has gained this experience through working as a staff engineer with the California Regional Water Quality Control Board (San Francisco Bay Region), as staff specialist (and Post-doc fellow) with the School of Public Health at the University of California, Berkeley, project manager/researcher for the Public Health Institute, and as a consulting engineer. He is currently the Vice president of EOA, Inc., where he manages a variety of projects, including serving as Santa Clara County Urban Runoff Program's Manager since 1998. Olivieri is also the author or co-author of numerous technical publications and project reports. He received a B.S. in Civil Engineering from the University of Connecticut, an M.S. in Civil and Sanitary Engineering from the University of Connecticut, and both an MPH and Dr.PH in Environmental Health Sciences from University of California, Berkeley.

James Crook, Ph.D., P.E. (Panel Co-Chair)
Water Reuse and Environmental Engineering Consultant (Boston, MA)

Jim Crook is an environmental engineer with more than 40 years of experience in state government and consulting engineering arenas, serving public and private sectors in the U.S. and abroad. He has authored more than 100 publications and is an internationally recognized expert in water reclamation and reuse. He has been involved in numerous projects and research activities involving public health, regulations and permitting, water quality, risk assessment, treatment technology, and all facets of water reuse. Crook spent 15 years directing the California Department of Health Services' water reuse program, during which time he developed California's first comprehensive water reuse criteria. He also spent 15 years with consulting firms overseeing water reuse activities and is now an independent consultant specializing in water reuse. He currently serves on several advisory panels and committees sponsored by NWRI and others. Among his honors, he was selected as the American Academy of Environmental Engineers' 2002 Kappe Lecturer and the WateReuse Association's 2005 Person of the Year. Crook received a B.S. in Civil Engineering from the University of Massachusetts and both an M.S. and Ph.D. in Environmental Engineering from the University of Cincinnati.

Michael Anderson, Ph.D.
Professor of Applied Limnology and Environmental Chemistry and Chair
Department of Environmental Sciences
University of California, Riverside (Riverside, CA)

Michael Anderson, a Professor of Applied Limnology and Environmental Chemistry, has taught courses at the University of California, Riverside, since 1990. His research focus includes water and soil sciences, with particular emphasis in applied limnology and lake/reservoir management; surface water quality and modeling; fate of contaminants in waters, soils, and sediments; and environmental chemistry. Current research projects include laboratory, field, and modeling studies in support of the development of species conservation habitat at the Salton Sea, sponsored by the California DWR and DFG, and a survey of organochlorine pesticides and Polychlorinated Biphenyls (PCBs) in McGrath Lake that is funded by the Los Angeles Regional Water Quality Control Board. He and his students also recently completed studies quantifying the abundance and distribution of quagga mussel veligers in the reservoirs of the Colorado River Aqueduct, as well as assessing the ecological and biological conditions at Lake Elsinore. In addition, he has served on various panels and workgroups, including as member of the California Department of Water Resource's Salton Sea Hydrologic Technical Workgroup (2007-2008). Anderson received a B.S. in Biology from Illinois Benedictine College, M.S. in Environmental Studies from Bemidji State University, and Ph.D. in Environmental Chemistry from Virginia Tech.

Richard Bull, Ph.D.
Consulting Toxicologist
MoBull Consulting (Richland, WA)

Since 2000, Richard Bull has been a Consulting Toxicologist with MoBull Consulting, where he conducts studies on the chemical problems encountered in water for water utilities, as well as federal, state, and local governments. Bull is a Professor Emeritus at Washington State University, where he maintains Adjunct Professor appointments in the College of Pharmacy and the Department of Environmental Science. Formerly, he served as a senior staff scientist at DOE's Pacific Northwest National Laboratory, Professor of Pharmacology/Toxicology at Washington State University, and Director of the Toxicology and Microbiology Division in the Cincinnati Laboratories for the U.S. Environmental Protection Agency. Bull has published extensively on research on central nervous system effects of heavy metals, the carcinogenic and toxicological effects of disinfectants and disinfection by-products, halogenated solvents, acrylamide, and other contaminants of drinking water. He has also served on many international scientific committees convened by the National Academy of Sciences, World Health Organization, and International Agency for Research on Cancer regarding various contaminants of drinking water. Bull received a B.S. in Pharmacy from the University of Washington and a Ph.D. in Pharmacology from the University of California, San Francisco.

Dr.-Ing. Jörg E. Drewes
Chair Professor, Chair of Urban Water Systems Engineering
Technische Universität München (Munich, Germany)

Jörg Drewes joined the Technische Universität München in 2013. Prior, he was a professor in the Department of Civil and Environmental Engineering at Colorado School of Mines (CSM), where he taught from 2001 to 2013. While at CSM, he served as the Director of Research for the National Science Foundation's Engineering Research Center *ReNUWIt* (which included Stanford University, University of California Berkeley, New Mexico State University, and CSM). He also served as Co-Director of CSM's Advanced Water Technology Center (AQWATEC). Drewes is actively involved in research in the areas of energy efficient water treatment and non-potable and potable water reuse. Current research interests include treatment technologies leading to potable reuse and the fate and transport of persistent organic compounds in these systems. He has published more than 250 journal papers, book contributions, and conference proceedings, and served on National Research Council Committees on *Water Reuse as an Approach for Meeting Future Water Supply Needs* and *Onsite Reuse of Graywater and Stormwater*. He also currently serves as Chair of the International Water Association (IWA) Water Reuse Specialist Group. Drewes received a Cand. Ing. (B.S.), Dipl. Ing. (M.S.), and Doctorate (Dr.-Ing.) in Environmental Engineering from the Technical University of Berlin, Germany.

Charles Haas, Ph.D.
Department Head, L.D. Betz Professor of Environmental Engineering
Drexel University (Philadelphia, PA)

Charles Haas is the Department Head of the Civil, Architectural, and Environmental Engineering at Drexel University since 1991. He is also the L.D. Betz Professor of Environmental Engineering and Director of the Drexel Engineering Cities Initiative. Prior to joining Drexel, he served on the faculties of Rensselaer Polytechnic Institute and the Illinois Institute of Technology. Haas specializes in water treatment, risk assessment, environmental modeling and statistics, microbiology, and environmental health. He received a B.S. in Biology and M.S. in Environmental Engineering, both from the Illinois Institute of Technology. He also received a Ph.D. in Environmental Engineering from the University of Illinois at Urbana-Champaign.

Walter Jakubowski, M.S.
Consultant
WaltJay Consulting (Spokane, WA)

Walter Jakubowski has degrees in Pharmacy from Brooklyn College of Pharmacy, Long Island University; in microbiology from Oregon State University, and graduate training in epidemiology from the University of Minnesota. He has research publications on hospital pharmacy; on microorganisms in oysters and clams under the federal Shellfish Sanitation

Program, and more than 40 peer-reviewed publications on determining the health effects and public health significance of pathogens, especially intestinal protozoa and viruses, in drinking water, waste water and municipal sewage sludge. He has served as a consultant to the World Health Organization on pathogenic intestinal protozoa (for development of the International Drinking Water Guidelines), and to the Pan-American Health Organization on environmental virus methods. He was instrumental in conducting the first international symposium on *Legionella* and Legionnaire's Disease at the Centers for Disease Control. He has more than 48 years of experience working with waterborne pathogens, especially enteric viruses, *Giardia* and *Cryptosporidium.* He initiated landmark studies on the human infectious dose of *Cryptosporidium* and chaired the Joint Task Group on Pathogenic Intestinal Protozoa for *Standard Methods for the Examination of Water and Waste Water* from 1978 to 2005. He was a charter member of U.S. EPA's Pathogen Equivalency Committee and served on that committee until his retirement from the U.S. Public Health Service/Environmental Protection Agency in 1997. Since then, he has been practicing as a private consultant while serving on various professional committees, panels, and boards.

Perry McCarty, Sc.D.
Silas H. Palmer Professor of Civil and Environmental Engr. Emeritus
Stanford University (Stanford, CA)

Perry McCarty is the Silas H. Palmer Professor of Civil and Environmental Engineering Emeritus at Stanford University. McCarty received the Clarke Prize Award in 1997 for his significant contributions to the areas of water treatment, reclamation, groundwater recharge, and water chemistry and microbiology. He is universally recognized for his research on understanding contaminant behavior in groundwater aquifers and sediments. McCarty has received numerous honors, including being elected to the National Academy of Engineering and American Academy of Arts and Sciences, as well as receiving an honorary doctorate from the Colorado School of Mines. He was also awarded the John and Alice Tyler Prize for Environmental Achievement in 1992 and the Stockholm Water Prize in 2007. McCarty received his B.S. from Wayne State University, and both his M.S. and Sc.D. from Massachusetts Institute of Technology.

Kara Nelson, Ph.D.
Professor
University of California, Berkeley (Berkeley, CA)

Kara Nelson is a Professor in Civil and Environmental Engineering at the University of California, Berkeley. She received her B.A. degree in biophysics from U.C. Berkeley, her M.S.E. degree in environmental engineering from the University of Washington, and her Ph.D. in environmental engineering from U.C. Davis. Her research program addresses critical issues at the intersection of public health and the environment, with a focus on reducing the threat posed by waterborne pathogens by improving our engineering infrastructure to make it more effective,

affordable, as well as maximize its environmental benefits. Specific research areas include mechanisms of pathogen inactivation, molecular techniques for pathogen detection, optimizing treatment processes, water reuse, and challenges with providing safe drinking water and sanitation in the developing world. Dr. Nelson has published over 50 articles in peer-reviewed journals, including two invited reviews, and one book chapter. She is the Director of Graduate Education at the National Science Foundation Engineering Research Center for Reinventing our Nation's Urban Water Infrastructure (ReNUWIt), the faculty leader of the Research Thrust Area on Safe Water and Sanitation at Berkeley Water Center. Dr. Nelson was awarded the Presidential Early Career Award for Scientists and Engineers (PECASE) at a ceremony in the White House in 2004. This award is the nation's highest honor for scientists in the early stages of their career.

Joan B. Rose, Ph.D.
Homer Nowlin Endowed Chair for Water Research
Michigan State University (East Lansing, MI)

Joan Rose, a professor at Michigan State University, has made groundbreaking advances in understanding water quality and protecting public health for more than 20 years and has published over 300 articles. She is widely regarded as the world's foremost authority on the microorganism *Cryptosporidium* and was the first person to present a method for detecting this pathogen in water supplies. She examines full-scale water treatment systems for the removal of pathogens. In 2001, she received the Athalie Richardson Irvine Clarke Prize from NWRI for her advances in microbial water-quality issues. She served as the Chair of the Science Advisory Board for the U.S. Environmental Protection Agency's Drinking Water Committee for 4 years, and currently serves on the Science Advisory Board for the Great Lakes. In addition, she is Co-Director of the Center for Water Sciences (which includes work with the Great Lakes and Human Health Center of the National Oceanic & Atmospheric Administration) at Michigan State University, where she is also Director of the Center for Advancing Microbial Risk Assessment. Rose received a B.S. in Microbiology from the University of Arizona, an M.S. in Microbiology from the University of Wyoming, and a Ph.D. in Microbiology from the University of Arizona.

David Sedlak, Ph.D.
Malozemoff Professor, Department of Civil and Environmental Engineering
University of California, Berkeley (Berkeley, CA)

David Sedlak is a Professor of Civil and Environmental Engineering at the University of California, Berkeley. He is also Co-Director of the Berkeley Water Center and Deputy Director of the National Science Foundation's Engineering Research Center for Reinventing the Nation's Urban Water Infrastructure (ReNUWIt). His research focus is on the fate of chemical contaminants, with the long-term goal of developing cost-effective, safe, and sustainable systems to manage water resources. Sedlak's previous experience includes Staff Scientist at ENVIRON Corporation and membership on the National Research Council's Committee on Water Reuse.

He has individually or co-authored over 70 peer-reviewed publications, among many other publications and presentations. Sedlak published a book in 2014 called "Water 4.0: The Past, Present, and Future of The World's Most Vital Resource," where he points out that most of the population gives little thought to the hidden systems that bring us water and take it away and how these marvels of engineering face challenges that cannot be solved without a fundamental change to our relationship with water. Sedlak received a B.S. in Environmental Science from Cornell University and a Ph.D. in Water Chemistry from the University of Wisconsin.

Tim Wade, Ph.D.
Epidemiology Branch Chief
United States Environmental Protection Agency (Durham, NC)

Tim Wade is the Epidemiology Branch Chief at the United States Environmental Protection Agency (U.S. EPA) and Assistant Professor of Epidemiology at the University of North Carolina, Chapel Hill. Wade has been working with the U.S. EPA since 2005, conducting a series of epidemiologic studies to evaluate the health effects of arsenic exposure in well water in Inner Mongolia. As Branch Chief, Wade determines research priorities, directs staff and post-doctoral students, and manages an annual budget of over $1 million annually. In 2011, Wade received the EPA Office of Water Bronze Medal for his exceptional service to the Office of Water in the development of recreational water quality criteria. He received a B.A. in Biological Science from California Polytechnic at Pomona, a B.A. in Psychobiology from Claremont McKenna College, and both an MPH and Ph.D. in Epidemiology from the University of California at Berkeley.

APPENDIX D: Panel Meeting #7 Agenda

NATIONAL WATER RESEARCH INSTITUTE

Expert Panel

SWRCB's Division of Drinking Water (DDW)
Development of Water Recycling Criteria for
Indirect Potable Reuse through Surface Water Augmentation and the
Feasibility of Developing Criteria for Direct Potable Reuse

Meeting #7 Final Agenda
December 1-2, 2015

LOCATION
Irvine Marriott Hotel
18000 Von Karman Avenue
Irvine, CA 92612
(949) 553-0100
Irvine/Los Angeles Room

CONTACTS
Jeff Mosher (Cell)
(714) 705-3722
Brandi Caskey (NWRI Office)
(714) 378-3278

Meeting Objectives:

- Finalize Panel Meeting Report #6.
- Status of DPR Briefing papers.
- Review and Accept Briefing paper #1 (Bioanalytical Tools).
- Initial Review of Briefing paper #2 (Reliability).
- Review Panel DPR Schedule.
- Status of SWA Criteria –SWB-DDW staff presentation.
- Discussion on December 15 SWRCB presentation.

Tuesday, December 1, 2015

Closed Session Starts at 8:30 am

8:30 am	Welcome and Introductions	Jeff Mosher, NWRI
8:45 am	Review Agenda and Meeting Objectives	Adam Olivieri and Jim Crook, Panel Co-Chairs
9:00 am	Finalize Draft Panel Report from Meeting #6	Panel Co-Chairs
10:15 am	**Break**	

10:30 am	Presentation and Discussion of DPR Briefing Paper #1: Bioanalytical Tools	Dick Bull, Panel Member
12:00 noon	**Lunch**	**Poolside**
1:00 pm	Finalize DPR Briefing Paper #1	Dick Bull
1:30 pm	Discussion of DDW Staff Letter – Alternative Reservoir Criteria	Panel Co-Chairs
2:00 pm	Discussion/Input on DPR Pilot Project Reliability (WRRF 14-12)	Panel Co-Chairs
2:15 pm	**Break and Internal Briefing Paper Group Discussions**	
2:45 pm	Status and Discussion on Briefing Paper #2: Reliability	Chuck Haas, Jörg Drewes, and Panel members
3:15 pm	Discussion/Input on December 15 Presentation to SWRCB Board Members	Panel Co-Chairs
3:30 pm	Status Update on Remaining DPR Briefing Papers (#3-#7)	Lead Authors
4:45 pm	Wrap Up	Panel Co-Chairs
5:00 pm	**ADJOURN**	

Wednesday, December 2, 2015

Open Session (with DDW) Starts at 8:30 am

8:30 am	Welcome and Introductions	Panel Co-Chairs
8:45 am	Summary of DPR Discussions	Panel Co-Chairs
9:15 am	DPR Advisory Group Update	Ray Trembley, Advisory Group Representative
9:45 am	Status of SWA IPR criteria	DDW Staff
10:30 am	**Break**	
10:45 am	Open Discussion	Panel Co-Chairs
11:15 am	Status of WateReuse DPR Initiative	Jeff Mosher
11:45 am	Discussion of December SWRCB Board Presentation	DDW Staff

12:15 pm	**Lunch (with DDW)**	**Poolside**
Closed Session Starts at 1:00 pm		
1:00 pm	Wrap Up and Next Steps (e.g., Panel Schedule)	Panel Co-Chairs
2:30 pm	**ADJOURN**	

APPENDIX E: Panel Meeting #7 Attendees

Panel Members:

- *Panel Co-Chair:* Adam Olivieri, Dr.P.H., P.E., EOA, Inc. (Oakland, CA)
- *Panel Co-Chair:* James Crook, Ph.D., P.E., Environmental Engineering Consultant (Boston, MA)
- Michael Anderson, Ph.D., University of California, Riverside (Riverside, CA)
- Richard Bull, Ph.D., MoBull Consulting (Richland, WA)
- Dr.-Ing. Jörg E. Drewes, Technische Universität München (Munich, Germany)
- Charles Haas, Ph.D., P.E., Drexel University (Philadelphia, PA)
- Walter Jakubowski, M.S., WaltJay Consulting (Spokane, Washington)
- Kara Nelson, Ph.D., University of California, Berkeley (Berkeley, CA)
- Joan B. Rose, Ph.D., Michigan State University (East Lansing, MI) (on phone, Day 2)
- David Sedlak, Ph.D., University of California, Berkeley (Berkeley, CA)
- Tim Wade, Ph.D., United States Environmental Protection Agency (Durham, NC) (on phone, Days 1 and 2)

National Water Research Institute:

- Suzanne Faubl, Water Resources Scientist and Project Manager
- Jeff Mosher, Executive Director
- Gina Vartanian, Outreach and Communications Manager

State Water Resources Control Board, Division of Drinking Water:

- Faraz Asad
- Randy Barnard, P.E.
- Mark Bartson, P.E.
- Brian Bernados, P.E.
- Jing-Tying Chao, P.E.
- Karen Larsen
- Sherly Rosilela, P.E.
- Kurt Souza, P.E. (on phone, Day 2)
- Erica Wolski, P.E. (on phone, Day 2)

California Department of Water Resources:

- Nancy King (on phone, Day 2)
- Richard Mills (on phone, Day 2)

State Board's DPR Advisory Group:

- Jim Fiedler, Santa Clara Valley Water District (on phone, Day 2)
- Ray Tremblay, Los Angeles County Sanitation Districts