

NATIONAL WATER RESEARCH INSTITUTE

**Final Panel Meeting Report #8:
Direct Potable Reuse**

Based on an Expert Panel Meeting Held February 23-24, 2016
(Panel Meeting #8)

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)

Submitted:
September 12, 2016

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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Publication Number: NWRI-2016-02

ACKNOWLEDGMENTS

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 process. 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, as well as and State Board retired annuitants Mr. Robert Hultquist and Dr. David Spath, 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; Ms. Brandi Caskey, Ms. Suzanne Faubl, and Ms. Jaime Lumia for their support in organizing the meetings; and Ms. Gina Vartanian for help with 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 Panel Meeting 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 Panel Meeting Report were prepared by the Panel. This Panel Meeting Report was published for informational purposes.

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ACRONYMS

| | |
|-------------|---|
| AR | Antibiotic resistance |
| ARB | Antibiotic resistant bacteria |
| ARG | Antibiotic resistance genes |
| ATW | Advanced treated water |
| CDPH | California Department of Public Health |
| CWC | California Water Code |
| DDW | Division of Drinking Water of the State Water Resources Control Board |
| 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 Panel Meeting Report is to provide the Division of Drinking Water (DDW) of the State Water Resources Control Board (State Board) with a summary of the Expert Panel's findings and recommendations on the topics discussed and information shared by the Panel at a meeting held on February 23-24, 2016 (Meeting #8) in Berkeley, California. Specifically, Meeting #8 focused on:

- The topic-based Briefing Papers on direct potable reuse (DPR) currently being prepared by the Panel.
- The Panel's final product, a "Panel Feasibility Report" on the feasibility of developing criteria for DPR that will incorporate information from the Briefing Papers to address and fulfill the Panel's charge per the California Water Code (CWC).

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 Water Resources Control Board (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 (CWC)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 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 the State Board to meet the following State-mandated deadlines, as required in the CWC regarding investigating the feasibility of developing uniform water recycling criteria for DPR:

- “On or before June 30, 2016, the department [State Board] shall prepare a draft report summarizing the recommendations of the Expert Panel” [CWC, Section 13565(c)].
- “The department [State Board] shall complete a public review draft of its report by September 1, 2016” [CWC, Section 13563(a)(1)].
- “The department [State Board] shall provide a final report to the Legislature by December 31, 2016” [CWC, Section 13563(a)(3)].

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 CWC 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 Panel is using a “Briefing Paper” approach to address and fulfill its charge, per the CWC, to investigate the feasibility of developing 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. Briefing Papers will be authored by Panel members and reviewed and accepted by the overall Panel. Papers will focus on one technical or scientific topic and address: (1) relevance to the Panel’s charge; (2) pertinent available technical and/or research information; and (3) overall Panel findings, conclusions, and recommendations (e.g., practical engineering/monitoring solutions and research topics/approach). The Panel will compile and summarize key points from all the Briefing Papers into a “Panel Feasibility Report” on the feasibility of developing uniform water recycling criteria for DPR.

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 content, is provided below.

1. **Application of Bioanalytical Tools to Water Analyses** – Issues related to the use of *in vitro* bioassays for advanced treated water (ATW) and drinking water.
2. **Quantifying Treatment Facility Reliability** – 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 for Measuring Chemical Water Quality** – Approaches for assessing chemical water quality in ATW and drinking water (with an emphasis on indicators and surrogates).
4. **Molecular and Other Methods for Monitoring Pathogens** – Monitoring indicators, surrogates, and pathogens in ATW and drinking water.
5. **Antibiotic Resistant Bacteria and Antibiotic Resistance Genes** – 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

The Panel has identified tasks, deadline dates, and meeting dates to facilitate the development and completion of the DPR Briefing Papers and the Panel Feasibility Report on the feasibility of developing uniform water recycling criteria for DPR. A summary of Panel deliverables is provided in Table 1 that includes the lead author and co-authors, Panel meeting dates in relation

to the preparation and internal review of the Briefing Papers, current status of the Briefing Papers, and preparation of the draft and final versions of the Panel Feasibility Report based on findings and recommendations from the Briefing Papers.

Table 1: Expert Panel Deliverables

| Panel Deliverables | Panel Lead/ Other Authors | Panel Review Meeting Dates ^a | Status as of 3/16/2016 |
|---|---|---|--|
| Briefing Papers (Note: numbering is for convenience and does not reflect the chapter order within the Panel Feasibility Report) | | | |
| 1 Application of Bioanalytical Tools to Water Analyses | Richard Bull (*outside assistance from Michael Denison and Kevin Crofton) | Nearing Internal Completion | Final draft reviewed at Meeting #8; final edits underway |
| 2 Quantifying Treatment Facility Reliability | Charles Haas/ Jörg Drewes/ Perry McCarty/ Kara Nelson/Panel | Meeting #9 (first draft); Meeting #10 (final draft) | Preliminary write-up reviewed at Meeting #8; authors currently working on completing a more detailed draft |
| 3 Analytical Methods/Tools for Measuring Chemical Water Quality | Davis Sedlak/ Jörg Drewes | Meeting #10 (first draft) | First draft under development |
| 4 Molecular and Other Methods for Monitoring Pathogens | Joan Rose and Kara Nelson | Meeting #10 (first draft) | Authors currently working on first draft |
| 5 Antibiotic Resistant Bacteria and Antibiotic Resistance Genes | Walter Jakubowski/ *Ryan Reinke/ *Kellogg Schwab | Meeting #8 (first draft) | Updated draft sent to Panel for review on March 1 |
| 6 Comparative Health Risks | Adam Olivieri and James Crook/Panel | Meeting #9 (outline); Meeting #12 (draft) | Outline under development |
| 7 Public Health Surveillance | Tim Wade/ Walter Jakubowski/ Michael Anderson | Meeting #11 (outline/notes); Meeting #12 (draft) | Status of paper discussed at Meeting #8; white paper under development by WasteReuse (Project No. WRRF 14-14) will be used to address some issues in this Briefing Paper |
| Preliminary Findings and Recommendations from Briefing Papers | Adam Olivieri and James Crook/Panel | Meeting #11 (internal draft) | Under development (reliant upon completion of each Briefing Paper) |
| Preliminary Research Recommendations from Briefing Papers | Adam Olivieri and James Crook/Panel | Meeting #11 (internal draft) | Under development (reliant upon completion of each Briefing Paper) |
| Draft Panel Feasibility Report | Adam Olivieri and James Crook/Panel | Meeting #9 (Draft Introduction) Meeting #11 (rough draft); Meeting #12 (draft); Meeting #13 (final draft); | Introduction is under development Report template developed, and Table of Contents provided to State Board in Feb 2016 (edited based on Panel review). (Final draft to be submitted to State Board in mid-July 2016) |
| Final Panel Feasibility Report | Adam Olivieri and James Crook/Panel | | Address State Board clarifications; submit to State Board in Sept. 2016 |

^a Notes on Panel meeting dates:

- Meeting #8: February 23-24, 2016 (completed)
- Meeting #9: March 30-31, 2016
- Meeting #10: April 13-14, 2016
- Meeting #11: May 11-12, 2016
- Meeting #12: Early June 2016 (small working group – date and location not set, main topic is preparing the draft Panel Feasibility Report)
- Meeting #13: June 29-30, 2016

* Non-Panel assistance and/or co-authors (invited).

PANEL MEETING #8

A two-day meeting of the Panel (Panel Meeting #8) was held on February 23-24, 2016, at the Hotel Shattuck Plaza in Berkeley, California. The specific focus of the meeting was on (1) the development and review of the DPR Briefing Papers and (2) structure of the Panel Feasibility Report.

4.1 Panel Meeting #8 Background Material

Prior to Meeting #8, the following background material was provided to the Panel:

- Draft of *DPR Briefing Paper #1: Application of Bioanalytical Tools to Water Analyses* (64 pages), authored by R. Bull (with assistance from K. Crofton and M. Dennison) and dated February 12, 2016.
- Draft of *Briefing Paper #2: Quantifying Treatment Facility Reliability* (24 pages), authored by C. Haas, J. Drewes, P. McCarty, and K. Nelson and dated February 12, 2016.
- Draft of *Briefing Paper #5: Antibiotic Resistant Bacteria and Antibiotic Resistance Genes* (44 pages), authored by W. Jakubowski, R. Reinke, and K. Schwab and dated February 12, 2016.
- Template for the Panel Feasibility Report on the *Evaluation of the Feasibility of Developing Direct Potable Reuse Regulatory Criteria for the State of California*, to be prepared by the Expert Panel on the Feasibility of Developing Criteria for Direct Potable Reuse and dated February 12, 2016.
- Presentation slides on “San Diego Pilot Plant Reliability Analysis and Discussion,” prepared by B. Pecson, S. Triolo, R.S. Trussell, and ARC Alternatives, dated January 29, 2016.

4.2 Panel Meeting #8 Agenda and Logistics

The Panel Co-Chairs and NWRI staff collaborated on the development of an agenda for Panel Meeting #8, which is included in Appendix D. The agenda was based on meeting the following objectives:

- Review the status of Briefing Papers not on the agenda.
- Finalize *Briefing Paper #1 on Application of Bioanalytical Tools to Water Analyses*.
- Review drafts of the following DPR Briefing Papers:
 - *Briefing Paper #2 on Quantifying Treatment Facility Reliability*.
 - *Briefing Paper #5 on Antibiotic Resistant Bacteria and Antibiotic Resistance Genes*.
- Review the template for the Panel Feasibility Report.

- Review the Panel meeting schedule and list of topics for discussion.

On Day 1, the Panel met in a closed session to (1) provide a status update on Briefing Papers that have yet to be drafted, (2) review the final draft of Briefing Paper #1 (Bioanalytical Tools), and (3) review the preliminary draft for Briefing Paper #2 (Reliability). The lead authors of Briefing Papers #1 and #2 provided presentations and led discussions about their papers. Edits were made, as needed, to the working drafts. In addition, the Panel also determined how the information from all seven Briefing Papers would be best organized within the Panel Feasibility Report by modifying the Table of Contents within the template for the Panel Feasibility Report.

On Day 2, again in closed session, the Panel continued its review of Briefing Paper #2 and reviewed a complete draft of Briefing Paper #5 (Antibiotic Resistance). The co-authors of Briefing Paper #5 provided a presentation on the information within the paper and made edits to the document, as needed.

4.3 Panel Meeting #8 Attendees

All but two Panel members attended Meeting #8 in person. Drs. Rose and Sedlak were unable to attend the meeting. Other attendees included NWRI staff and the co-author of Briefing Paper #5 (Antibiotic Resistance), Dr. Ryan Reinke of the County Sanitation Districts of Los Angeles County. The meeting was closed to allow the Panel to make maximum use of its time to review and work on the Briefing Papers. A complete list of Panel meeting attendees is included in Appendix E.

5. SUMMARY OF PANEL COMMENTS AND RECOMMENDATIONS

The Panel has organized this report to reflect the meeting agenda and material presented and discussed at Meeting #8. Sections include:

- General Statements
- DPR Briefing Papers and Panel Feasibility Report

These topic-based comments and recommendations are provided below.

5.1 General Statements

- The Panel appreciates the continued support, responsiveness, and information provided by State Board staff throughout this process.
- The Panel will need both working days at the next Panel meeting (Meeting #9, scheduled for March 30-31, 2016) to review and discuss the DPR Briefing Papers; therefore, Meeting #9 will be open only to Panel members and invited technical experts, as determined by the Panel.
- The Panel concluded that the release of the internal draft DPR Briefing Papers was not appropriate. The Panel reiterated that the current approach of releasing a bullet-point summary of Briefing Paper conclusions in the Panel Meeting Reports and as part of the updates to the DPR Advisory Group provide the appropriate level of information at this time.

5.2 DPR Briefing Papers and Panel Feasibility Report

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.

5.2.1 Briefing Paper #1 on Application of Bioanalytical Tools to Water Analyses

Dr. Richard Bull provided a 64-page final draft of *Briefing Paper #1: Application of Bioanalytical Tools to Water Analyses* (dated February 12, 2016). The Panel had the opportunity to review the draft and received a presentation on the subject matter by Dr. Bull. The Briefing Paper is under final review and nearing completion; however, the Panel has recommended reorganizing the findings and recommendations for consistency, as well as prioritizing them.

Action – The Panel Co-Chairs will work with Dr. Drewes to provide suggested edits to Dr. Bull on reorganizing and linking Sections 8 and 9 (conclusions and recommendations). The updated sections will be distributed to the entire Panel for a brief review prior to Panel Meeting #9.

5.2.2 Briefing Paper #2 on Quantifying Treatment Facility Reliability

A 24-page draft of *Briefing Paper #2: Quantifying Treatment Facility Reliability* (dated February 12, 2016) was provided to the Panel for review at Meeting #8. A presentation on the subject matter was given by Dr. Charles Haas with assistance from Drs. Jörg Drewes, Perry McCarty, and Kara Nelson. The next draft will be reviewed at Meeting #9.

Notable points made during the Panel discussion include:

- The Briefing Paper will include a definition, as well discussion, of the underlying assumptions of “reliability” as it relates to advanced water treatment within a DPR project.
- The Briefing Paper will include a review of the basis for the SWA pathogen log reduction values (LRVs) (including the requirement that overall treatment achieve at least 12-log virus reduction, 10-log *Giardia* reduction, and 10-log *Cryptosporidium* reduction) and the relationship to DPR projects, as well as examine the LRVs for selected groundwater recharge projects.
- The Briefing Paper will address the subject of defining performance criteria for regulated and unregulated chemicals.
- The Briefing Paper will explore possible alternatives to the environmental buffer, specifically addressing treatment technology and time to respond.

5.2.3 Briefing Paper #3 on Analytical Methods/Tools for Measuring Chemical Water Quality

Dr. Jörg Drewes provided a brief update on the status of *Briefing Paper #3 on Analytical Methods/Tools for Measuring Chemical Water Quality*. A first draft is under development and will be reviewed at Meeting #10.

Notable points made during the Panel discussion include:

- Close coordination between this paper and Briefing Papers #2 (Reliability) and #4 (Pathogen Monitoring) is absolutely necessary.
- Briefing Paper #3 will examine:
 - Elements of chemical contaminant monitoring programs.
 - Chemical contaminants that could compromise water quality.
 - Broader measurements for non-target screenings for chemicals that might be present, but not yet identified.

- Chemicals and parameters that could provide insights into system performance.
- Frequency and location of monitoring.
- The need for an adaptive monitoring framework to identify and address excursions.

Action – The Co-Chairs will follow up with State Board staff as to whether any new data are available in response to the State Board’s Expert Panel on chemicals of emerging concern.

5.2.4 Briefing Paper #4 on Molecular and Other Methods for Monitoring Pathogens

Dr. Kara Nelson briefly described work being undertaken on *Briefing Paper #4 on Molecular and Other Methods for Monitoring Pathogens*. The co-authors are currently working on a first draft, which will be reviewed at Meeting #10.

Dr. Nelson noted that this paper and Briefing Paper #3 (Measuring Chemicals) have similar sections and will discuss similar topics associated with the contaminants of concern, including detection methods, surrogates, and indicators; therefore, the co-authors of both Briefing Papers will coordinate the development of their Briefing Paper outlines to ensure parallel structure and avoid redundancy.

5.2.5 Briefing Paper #5 on Antibiotic Resistant Bacteria and Antibiotic Resistance Genes

Mr. Walter Jakubowski provided a complete draft of *Paper #5: Antibiotic Resistant Bacteria and Antibiotic Resistance Genes*. Along with co-author Dr. Ryan Reinke, he gave a presentation on the information provided within the Briefing Paper. Edits were suggested by the Panel, and the next draft will be completed prior to Meeting #9.

Preliminary findings, based on a comprehensive review of over 100 references, include:

1. Antibiotic resistance is a valid and serious worldwide public health concern.
2. Risk levels associated with antibiotic resistant bacteria (ARB) and antibiotic resistance genes (ARG) in water have not been determined.
3. Currently, it is unclear whether water is a significant disseminator of ARB and ARG relative to other sources.
4. Considering all the available information, concentrations of ARB and ARG from waters subjected to both secondary and advanced DPR treatment would likely be equal to or lower than that from current water sources entering drinking water treatment plants.

5. Thus, risk levels would be comparable to, or less than, those associated with current source waters.
6. ARB and ARG are found in other environments, such as soils, and other source waters (not necessarily impacted by wastewater).
7. Currently, there are no standardized tests for ARBs and ARGs in environmental samples.
8. The determination of ARB and ARG concentrations in water can be helpful in assessing the performance of treatment processes for the removal of antibiotic resistance (AR) determinants.
9. The Panel believes it is important to continue to characterize the role of potable water reuse in disseminating AR.
10. Ongoing research in the U.S., Europe, and Asia is looking at other sources (e.g., hospitals, agriculture) besides wastewater of ARGs and ARBs and their removal by different treatment processes.

Preliminary research recommendations were also discussed.

5.2.6 Briefing Paper #7 on Public Health Surveillance

Dr. Tim Wade provided a brief update on the status of *Briefing Paper #7 on Public Health Surveillance*. An outline, along with some bullet points for this Briefing Paper, is expected to be reviewed at Panel Meeting #11. The more detailed draft of the Briefing Paper is scheduled for review at Panel Meeting #12 (early June).

The Briefing Paper will be developed based on information provided from a WaterReuse Research Foundation (WRRF) project (Project No. WRRF 14-14) entitled “White Paper on the Feasibility of Establishing a Framework for Public Health Monitoring.” The project will focus on defining and describing the role for interaction with public health surveillance programs in relation to DPR projects. The project is being facilitated by Mr. Jeff Mosher of NWRI.

5.2.7 Other Briefing Paper/Report-Related Topics

The Panel discussed several other topics and identified several actions, as noted below:

- Panel Feasibility Report Template, including Table of Contents. The Panel reviewed and provided edits to the template for the Panel Feasibility Report.

Action – The Co-Chairs will revise the Table of Contents and insert more details on Briefing Papers #1 (Bioanalytical Tools) and #5 (Antibiotic Resistance) directly into the Table of Contents. Once completed, it will be distributed to the Panel and State Board staff as an internal draft document.

- Draft Meeting Schedule – The Panel reviewed and confirmed Panel Meeting dates and locations, and suggested several modifications to meeting topics.

Action – The Co-Chairs will update the Panel Meeting schedule and list of topics and distribute them to the Panel and State Board staff.

- Data Request for Briefing Paper #6 on Comparative Health Risks. The Panel briefly discussed a proposed approach for Briefing Paper #6. The comparative analysis will be conducted based on a potable source water comparison relying on the Sacramento-San Joaquin River Delta (Delta) and possibly one other source water (depending on available data), along with several combinations of ATW and drinking water. The comparative analysis approach will follow a similar approach used for the risk exemplar in the National Research Council report on *Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater (2012)*.

Action – The Co-Chairs will request available data (in addition to data contained in Guo et al., 2010²) from State Board staff on raw potable water source water quality for chemicals of emerging concern, constituents regulated by the Safe Drinking Water Act, and pathogens specifically for the Delta and perhaps one other source (e.g., the City of San Diego).

² Guo, Y.C., S.W. Krasner, S. Fitzsimmons, G. Woodside, and N. Yamachika (2010). Final Project Report: *Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California*. National Water Research Institute, Fountain Valley, CA.
<http://www.nwri-usa.org/pdfs/NWRIFinalReportEDCsPPCPsMay2010.pdf>

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 on the City San Diego Health Effects investigations for Aqua II and Aqua III and advanced treatment facility engineering performance and operation reports, 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 *ReNUWI*t (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.

NATIONAL WATER RESEARCH INSTITUTE

Expert Panel for 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

Agenda – Meeting #8 February 23-24, 2016

Meeting Location

Hotel Shattuck Plaza
2086 Allston Way
Berkeley, California 94704

Contacts

Jeff Mosher, NWRI
(714) 705-3722 (mobile)

Jaime Lumia, NWRI
(714) 378-3278 (NWRI office)

Meeting Objectives:

1. Status of Briefing Papers
2. Finalize Briefing Paper #1 (Bioanalytical Tools)
3. Review Draft Briefing Paper #2 (Reliability)
4. Review Draft Briefing Paper #5 (ARB/ARG)
5. Review Panel DPR Schedule

Tuesday, February 23, 2016

| | | |
|-------------------|---|---|
| 8:30 am | Welcome and Introductions | Adam Olivieri and Jim Crook, Panel Co-Chairs |
| 8:45 am | Review Agenda and Meeting Objectives | Adam Olivieri and Jim Crook, Panel Co-Chairs |
| 9:00 am | Status of Briefing Papers Not On Agenda | Adam Olivieri and Jim Crook, Panel Co-Chairs |
| 10:15 am | BREAK | |
| 10:30 am | Finalize Bioanalytical Briefing Paper #1 | Dick Bull, Panel Member |
| 12:00 noon | LUNCH | |
| 12:45 pm | Presentation and Discussion on Briefing Paper #2 (Reliability) | Chuck Haas and Jörg Drewes, Panel Members |
| 2:30 pm | BREAK | |

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| 2:45 pm | Continue Discussion on Briefing Paper #2 (Reliability) and Identify Next Steps to Finalize | Chuck Haas and Jörg Drewes, Panel Members |
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4:00 pm ADJOURN

Wednesday, February 24, 2016

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| 8:00 am | Review Agenda and Meeting Objectives | Adam Olivieri and Jim Crook, Panel Co-Chairs |
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| 8:15 am | Presentation and Discussion on Briefing Paper #5 (ARB/ARG) | *Walt Jakubowski, Panel |
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10:30 am BREAK

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|----------|--|------------------------|
| 10:45 am | Continue Discussion on Briefing Paper #5 (ARB/ARG) and Identify Next Steps to Finalize | Walt Jakubowski; Panel |
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12:00 pm LUNCH

| | | |
|----------|---|---|
| 12:45 pm | Wrap up Discussion on Briefing Paper #2 (Reliability) and Identify Next Steps to Finalize | Chuck Haas and Jörg Drewes, Panel Members |
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| 2:00 pm | Wrap Up and Next Steps (Panel Schedule) | Panel Co-Chairs |
|---------|---|-----------------|

2:30 pm ADJOURN

APPENDIX E: Panel Meeting #8 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., 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)
- Tim Wade, Ph.D., United States Environmental Protection Agency (Durham, NC)

National Water Research Institute:

- Suzanne Faubl, Water Resources Scientist and Project Manager (Fountain Valley, CA)
- Jeff Mosher, Executive Director (Fountain Valley, CA)
- Gina Vartanian, Outreach and Communications Manager (Fountain Valley, CA)

Others

- Ryan Reinke, Ph.D., Sanitation Districts of Los Angeles County (Los Angeles, CA)