

NATIONAL WATER RESEARCH INSTITUTE

Final Panel Report #1

Review of Metropolitan Water District's Regional Recycled Water Program Advanced Purification Center Demonstration Project

Based on the NWRI Independent Advisory Panel Meeting held
August 8-9, 2018 at Los Angeles, California

Prepared by:

NWRI Independent Scientific Advisory Panel for the
Regional Recycled Water Program
Advanced Purification Center Demonstration Project

Prepared for:

Metropolitan Water District of Southern California
Los Angeles, CA USA

Submitted by:

National Water Research Institute
Fountain Valley, CA USA

September 28, 2018

The logo for the National Water Research Institute (NWRI) is displayed in a large, blue, serif font. The letters are bold and closely spaced, with the 'N' and 'W' being particularly prominent.

DISCLAIMER

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

ABOUT NWRI

A joint powers authority and 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 JPA member agencies are: Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

For more information, please contact:

National Water Research Institute
18700 Ward Street
Fountain Valley, California, USA 92708
Phone: (714) 378-3278
www.nwri-usa.org

Kevin M. Hardy, Executive Director
Brandi Caskey, Administrative Manager
Mary Collins, Technical Editor
Dawna Hernandez, Event Manager
Suzanne Sharkey, Research Scientist & Project Manager

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INTRODUCTION

The National Water Research Institute (NWRI) is pleased to present this report on the findings and recommendations from Meeting #1 of the NWRI Independent Scientific Advisory Panel (Panel) for the Regional Recycled Water Program (RRWP), Advanced Purification Center Demonstration Project (Project). The Panel met on August 8-9, 2018 in Los Angeles, California.

REGIONAL RECYCLED WATER PROGRAM

The RRWP is a partnership of Metropolitan Water District of Southern California (Metropolitan) and the Sanitation Districts of Los Angeles County (LACSD). The partners are exploring the potential of a program to create a new water resource with regional benefit for Southern California. The RRWP would consist of an advanced water treatment (AWT) facility at the LACSD Joint Water Pollution Control Plant (JWPCP) in Carson, California, and a new regional conveyance system to beneficially reuse water currently discharged to the Pacific Ocean. Metropolitan and LACSD envision this AWT facility would treat secondary effluent from the JWPCP and with AWT processes to purify the water for recharge in Los Angeles and Orange counties. In the future, the potential exists for the Project to provide a source of water for other indirect and direct potable uses. The RRWP would diversify the region's water resources and significantly contribute to long-term water supply targets outlined in Metropolitan's Integrated Resources Plan.

California remains a leader in recycling wastewater for beneficial reuse. The RRWP would be designed to meet or exceed the water quality parameters of other successful indirect potable reuse (IPR) projects in California, including the Groundwater Replenishment System developed collaboratively by Orange County Water District and Orange County Sanitation District, and the Montebello Forebay Groundwater Recharge project owned and operated by LACSD. The RRWP design would direct purified water through a new regional distribution system for delivery to Metropolitan's member agencies to meet regional groundwater replenishment needs. Groundwater basins currently being considered as users of the RRWP product include West Coast Basin, Central Basin, Main San Gabriel Basin, and Orange County Basin. In addition to providing Metropolitan with a significant new drought-resistant water supply, the RRWP would contribute to the LACSD's goal to maximize reuse of treated wastewater. If Metropolitan and LACSD move forward with the RRWP, the full-scale facilities would likely be implemented over multiple phases to a maximum build-out of up to 150 million gallons per day (MGD).

ADVANCED PURIFICATION CENTER DEMONSTRATION PROJECT

The Project will provide critical input for the design of full-scale RRWP facilities, clarify capital and operational and maintenance costs for advanced treatment, and ultimately acquire the necessary regulatory permits for a full-scale facility should the RRWP proceed. The Project will build upon a successful pilot study conducted by Metropolitan and the Sanitation Districts between 2010 and 2012 evaluating two AWT process trains. Construction on the 500,000 gallon per day AWT demonstration plant, now known as the RRWP APC Demonstration Project, began in late 2017, and should be completed in late 2018.

The Project will enable the partners to test AWT processes to support regulatory acceptance of an advanced treatment train that includes a membrane bioreactor (MBR), filtration, and advanced oxidation (AO). It is noteworthy that this is the first potable reuse project in California that proposes a MBR as the core treatment process. The partners expect the

Project to operate for approximately one year and will provide opportunities for public outreach aimed at obtaining public acceptance for the RRWP. The partners engaged NWRI in early 2018 to administer and facilitate the Independent Scientific Advisory Panel for this Project as required by Title 22. The Panel's charge is to review the scientific, technical, and regulatory aspects of the Project.

NWRI PANEL PROCESS OVERVIEW

To ensure the success of Meeting #1, NWRI engaged the Project Planning Team, the Panel Chair, and Panel during June 2018, and organized multiple coordination meetings among these groups. The purpose of these meetings was to: (a) plan an effective process that met all expectations of Metropolitan-LACSD; (b) ensure good communication among Metropolitan-LACSD, the NWRI team, and the Panel; (c) focus the Panel's scope of review; and, (d) draft, review, and finalize the Key Questions to guide the Panel's Meeting #1 Findings and Recommendations.

Panel Meeting #1 was held August 8-9, 2018, at the Metropolitan Headquarters Building located at Union Station, 700 North Alameda Street, Los Angeles, California. The meeting was facilitated by Ed Means of Means Consulting LLC, under contract to NWRI. The following Panel members attended Meeting #1:

- Chair: Charles Haas, Ph.D., Expert in Microbiology, Drexel University
- Richard "Dick" Bull, Ph.D., Expert in Toxicology, MoBull Consulting
- Joseph Cotruvo, Ph.D., Expert in Chemistry, Joseph Cotruvo and Associates, LLC
- Adam Olivieri, PE, Dr.PH., Expert in Potable Reuse Permitting and Public Health, EOA, Inc.
- Thomas Harder; P.G., P.H.G., Expert in Hydrogeology, Thomas Harder & Co.
- Vernon Snoeyink, Ph.D., Expert in Corrosion; University of Illinois
- Paul Westerhoff, Ph.D., Expert in Water Treatment Technology & Process, Arizona State University

Michael Stenstrom, Ph.D., an expert in Wastewater Treatment Technology & Process at University of California, Los Angeles, was unable to attend. However, Dr. Stenstrom states that he reviewed the test plans and has no concerns with the Panel's consensus findings and recommendations.

Short biographies for each Panel member are provided in **Attachment A**. The Agenda for Meeting #1 is included as **Attachment B**, and a list of Meeting #1 Attendees is presented in **Attachment C**.

PANEL FINDINGS AND RECOMMENDATIONS

These Findings and Recommendations address the Metropolitan-LACSD Key Questions and respond to the presentations provided by Metropolitan, LACSD, and their consultants during the morning of August 8, 2018. The Panel's feedback is organized as answers to the Key Questions along with additional observations related to the scope of review.

Prior to the meeting, the Panel received the following documents for review: (1) Metropolitan Water District RRWP APC Demo Plant Testing and Monitoring Plan –Year 1 (June 8, 2018); and (2) LACSD APC Demo Facility Monitoring Plan (June 2018); and (3) LACSD Boron Source Investigation Report (January 12, 2018). The Panel relied on these

documents, the utility presentations listed in this report, the meeting agenda, the Key Questions, and their individual expertise to prepare for Meeting #1. The presentations will be available to view and download from Metropolitan's web site at <http://www.mwdh2o.com/DocSvcPubs/rrwp/index.html#home>.

- Presentation 1: Regional Recycled Water Program Overview
- Presentation 2: Monitoring Plan for JWPCP Compliance
- Presentation 3: Advanced Water Treatment Plant: Testing and Monitoring Plan

The Panel organized its closed working sessions on the afternoon of August 8th and the morning of August 9th to discuss the eight Key Questions. The Panel's responses to these questions are presented below.

QUESTION 1: Is the proposed approach for testing the membrane bioreactor (MBR) at the Demonstration Plant appropriate to validate pathogen log removal and achieve regulatory credit?

PANEL RESPONSE: Overall, the approach presented in the pre-meeting review materials and at Panel Meeting #1 is rational and reasonable, provided the following issues are addressed:

- The Panel understands the initial testing phase is designed to verify log removal credits for *Cryptosporidium* and *Giardia* by the MBR, which will be fed with secondary treated water (for the operational envelope described in the test plan).
- Metropolitan has assumed that log reduction values (LRVs) would increase when primary treated water is fed into the MBR; this assumption needs to be verified in practice.
- The Panel recommends a preliminary enumeration of *Cryptosporidium* and *Giardia* in the secondary effluent to ensure that the planned assessment can reliably demonstrate LRV greater than 2.5.
- The Panel recommends documenting how the 95th percentile removals for LRVs for *Cryptosporidium* and *Giardia* will be calculated from the data collected.
- Develop a project-specific Quality Assurance Project Plan (QAPP).

QUESTION 2: Is the approach for testing the reverse osmosis and ultraviolet light/advanced oxidation process appropriate for meeting the water quality and operational goals indicated in the testing and monitoring plan?

PANEL RESPONSE: Overall, the approach presented for testing the reverse osmosis (RO) and the ultraviolet/advanced oxidation process (UV/AOP) is appropriate for meeting the water quality and operational goals indicated in the testing and monitoring plan, provided the following issues are addressed:

- The Panel recommends the inclusion of a specific statement of purpose in the RO and UV/AOP Testing Plan (for example, to verify operational goals or and/or to achieve regulatory compliance).
 - Some nitrogenous chemicals are precursors for formation of nitrosamines.

- Develop criteria for RO-influent loading of (a) nitrate to meet effluent nitrogen goals, and (2) TOC to prevent membrane fouling.
- Verify nitrate removal during RO treatment to meet AWT effluent goals.
- Develop a response plan for use if a post-RO TOC spike should be detected. For example, the plan might require grab samples for separate characterization of spikes attributed to low molecular weight, neutral, and/or volatile compounds, which are not effectively treated by RO.
- The Panel recommends the Project Team coordinate monitoring of RO and UV/AOP effluent with changing MBR operations.
 - Document a strategy to address RO fouling (e.g., increase anti-scalants, cleaning regimes, backwashing with RO permeate, etc.) should it occur. The goal of reduced fouling is to maintain optimal operation of the MBR to achieve the required pathogen removal.
 - Consider size exclusion chromatography (LC-OCD, SEC-TOC) or fluorescence excitation-emission matrix organic characterization to determine fouling potential on the MBR as operational parameters change.
 - Define a plan to evaluate the use of RO permeate water for backwashing the RO membranes. IDE Technologies case studies indicate that RO permeate water may improve backwash efficiency in preventing long-term inorganic fouling of the RO membrane active surfaces.
- Conduct treated water holding studies to determine whether NDMA will be regenerated dependent upon final AOP (H₂O₂ versus chlorine) and distribution disinfection strategy (chlorine or chloramine).

QUESTION 3: Is the approach to test and monitor Demonstration Plant waste streams and brine discharges appropriate for full-scale evaluation on the JWPCP processes, secondary effluent quality, and brine management regulatory challenges?

PANEL RESPONSE: Overall, the approach presented for testing and monitoring the Demonstration Project waste streams and brine discharges is appropriate for full-scale evaluation. However, the flow and concentration/strength of wastewater discharged via the LACSD Outfall (Outfall) varies both on a regular diurnal basis, in response to changes in operational conditions, and as a result of changes to the volume of characteristics of flows influent to the JWPCP and its various side stream flows. At full scale, the Project would add a brine side stream flow to the Outfall. The additional brine side stream will vary in terms of volume and character as well. The intent of the following observations are to encourage the Project Team to evaluate impacts of the RO brine side stream on Outfall operations and to investigate how flow equalization could stabilize JWPCP operations, stabilize water quality discharged through the outfall, and simplify AWPC operations.

- The Panel recommends the Project Team re-examine the analytical plan for ensuring regulatory compliance for discharge.
 - Ensure that toxicity testing addresses a discharge stream of 100 percent brine as an extreme, although unlikely, boundary.
 - Evaluate “normal” condition in which brine is blended with secondary treated water.

- Measure orthophosphate in the waste activated sludge to address concerns with struvite formation as water flows back to JWPCP.
- The Panel recommends the Project Team assess the benefits of implementing flow equalization ahead of the JWPCP or AWTF to diminish the impacts of diurnal wastewater flow variations on AWTF operations, and, in developing strategies to manage brine produced by the AWTF.
- As return flows from the AWT increase with expansion, recommended analysis for future work includes:
 - Evaluate effects of waste stream recycling on primary and secondary process stability at the JWPCP.
 - Evaluate potential for scaling in the conveyance piping and Outfall structures.

QUESTION 4: What additional operational criteria should be considered in advanced water treatment process equipment evaluations?

PANEL RESPONSE

- The Panel recommends the Project Team clarify whether particle counts on the MBR effluent would provide any benefit for determining how to optimize the AWTF performance.
- It is unclear if organic matter or biofilm growth will control RO fouling, and no surrogate (beyond TOC) to predict RO fouling is identified in the testing plan. The Panel recommends the Project Team consider size exclusion chromatography, fluorescence, or other techniques if fouling of the RO membrane results from operation of the MBR.
- The Panel recommends the Project Team Develop criteria for RO influent loading of nitrate and TOC (validate nitrate removal from RO influent to meet AWT effluent goal).
- The Panel recommends the Project Team consider aerobic bacterial spores as a surrogate for *Cryptosporidium*.
 - Ambient spores may be more useful than spiking because they are ubiquitous, present in large quantities, of appropriate size, and easy to measure.
 - *Giardia* is more difficult to measure; spores may be used as a surrogate to determine LRVs for *Giardia*.
- The Panel recommends the Project Team consider effects of water conservation on source loading (future).

QUESTION 5: Which existing demonstration projects implemented by other agencies serve as good examples for the proposed project?

PANEL RESPONSE: The Panel identified the following facilities for comparative purposes.

- These MBR systems are relevant but not completely analogous:
 - Ironhouse Sanitary District (Oakley, CA)
 - City of Abilene Hamby Water Reclamation Facility and Indirect Reuse Project (Abilene, TX)
 - North Valley Regional Recycled Water Program (Modesto, CA)

- Healdsburg Wastewater Treatment Plant (Healdsburg, CA)
- King County Regional Wastewater Treatment System (King County, Washington)
- Comparable physical facilities in California.
 - Reverse osmosis: Orange County Water District (OCWD), Santa Clara Valley Water District (SCVWD), and City of San Diego
 - UV and Advanced Oxidation: OCWD, SCVWD, City of San Diego, Los Angeles Sanitation's Terminal Island Water Reclamation Plant (which uses chlorine)
- Instructive institutional settings,
 - Orange County Water District (Fountain Valley, CA)
 - Hampton Roads Sanitation District (Virginia Beach, VA)
 - Singapore Public Utilities Board
- The Panel recommends the Project Team begin developing a training program. Keep in mind that other agencies have used AWTP demonstration projects for operator training.
- The Panel recommends the Project Team develop an interactive educational program for public visitation/tours of the Demonstration Facility.

QUESTION 6: How should the make-up and variability of influent (i.e., JWPCP secondary effluent) to the Demonstration Project be monitored and evaluated?

PANEL RESPONSE:

- The Panel recommends the Project Team establish operational goals and response strategies for IPR (e.g., membrane fouling rate). An important critical control point is the JWPCP secondary effluent.
- The Panel recommends the Project Team identify water quality conditions, including chemical spikes, that could cause treatment train failure (MBR, RO, UV/AOP), or effluent quality to exceed target levels (e.g., tritium, acetone, certain neutral-charged industrial chemicals in the influent).
- The Panel recommends the Project Team determine whether perfluorinated compounds (e.g., Total Oxidizable Perfluorinated Assay) are a potential contaminant, and if so, which PFCs are present.
- The Panel recommends the Project Team conduct a source control assessment for tritium, nitrosamines and precursors, 1,4-dioxane, and boron in the major source, unless the public health goal (PHG) value can be modified or exempted based upon low toxicity. Use the findings to design the AWTF and determine (a) pretreatment requirements for chemicals and (b) control of release frequency and amounts for tritium.
- The Panel recommends the Project Team consider using sensors and programming for improved dosing (O₂ and carbon) into the MBR to manage variable diurnal nitrogen and carbon concentrations from the JWPCP.

- Note that future direct potable reuse (DPR) regulations could require more stringent water quality specifications, monitoring, and a more comprehensive source control and response plan than required for IPR projects. For example, compounds that have low molecular weight, are neutral or volatile may penetrate RO membranes.

QUESTION 7: Is the analytical methodology described in the testing and monitoring plan adequate for achieving the Demonstration Project objectives?

PANEL RESPONSE:

- The Panel recommends the Project Team develop appropriate monitoring frequency for organic molecules (including NDMA and 1,4-dioxane, and other chemicals found in substantial spills) that can be used as indicators of variability in the influent waste water.
 - Control of these variables will may require more frequent monitoring or a robust source control program to identify sources and limits on the amounts and frequency of release in the sewershed.
 - Consider total oxidizable precursor (TOP) assay for unidentified perfluorinated compounds, if they are determined to a contaminant of concern. Perfluorinated compounds should be removed by RO.
- The Panel recommends the Project Team document all intended QA/QC protocols for the sampling and analysis plan.
- The Panel recommends the Project Team articulate the basis for selecting monitoring parameters including surrogates, certain key pathogens, and selected chemicals of concern.
- The Panel recommends the Project Team link monitoring frequency to observed variability in concentrations of surrogates, certain key pathogens, and selected chemicals of concern.

QUESTION 8: What additional considerations or approaches should be included in the Demonstration Project testing and monitoring plan for validating the advanced water treatment processes being tested, for ultimate permitting of a groundwater replenishment project?

PANEL RESPONSE:

- The Panel recommends the Project Team develop a boron management strategy.
 - Enforce an appropriate source control program to reduce the amount of boron entering the waste water.
 - Create a pilot testing plan for selective boron removal from AWTF effluent, if necessary.
 - Seek congruence in the boron limits among Basin Plans.
 - Seek a variance in the Basin Plan, if appropriate.
- The Panel recommends the Project Team develop a plan to assess the need for post-RO stabilization, disinfection, and basin impacts.

ADDITIONAL RECOMMENDATIONS AND OBSERVATIONS

The Panel also offers the following comments on topics apart from the eight questions addressed above.

- **BORON.** The Panel would be interested in reviewing a future evaluation of the frequency of monitoring for boron and statistical distribution of boron detections.
- **EMERGING TECHNIQUES FOR DNA/GENETIC ANALYSIS.** The Panel noted that developments are proceeding with *omics technologies; other utilities are evaluating these methods.
- **FUTURE TESTING.** The Panel understands that Metropolitan is planning to conduct additional testing after Year One of the project. This future testing should address some of the Panel's recommendations.
- **COORDINATION OF EFFORT BETWEEN METROPOLITAN AND THE SANITATION DISTRICTS:**
 - The Panel recommends that Metropolitan and the Sanitation Districts develop joint research plans for Year Two (and future years) of the RRWP.
 - The Panel recommends that Metropolitan and the Sanitation Districts develop a comprehensive MOU for joint operation of the Demonstration Project.

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ATTACHMENT A: PANEL MEMBER BIOGRAPHIES

Independent Science Advisory Panel for Metropolitan Water District of Southern California Regional Recycled Water Program Advanced Purification Center Demonstration Project

Panel Chair: Charles N. Haas, Ph.D., Professor of Environmental Engineering and Head, Department of Civil, Architectural and Environmental Engineering, Drexel University

Dr. Charles Haas has more than 45 years of experience conducting research in water treatment, risk assessment, environmental modeling and statistics, microbiology, and environmental health. He has led the Department of Civil, Architectural, and Environmental Engineering at Drexel University since 1991, and previously served on the faculties of Rensselaer Polytechnic Institute and Illinois Institute of Technology. Haas holds a B.S. in Biology and an M.S. in Environmental Engineering from Illinois Institute of Technology, and a Ph.D. in Environmental and Civil Engineering from University of Illinois.

Richard J. Bull, Ph.D., MoBull Consulting (Professor Emeritus, Pharmacology/Toxicology, Washington State University)

Dr. Richard Bull has been involved in toxicological research for 45 years and has focused on human health effects of drinking water contaminants, including mechanisms of carcinogenesis of halogenated solvents and disinfectant by-products including trihalomethanes, haloacetic acids and bromate. He has been recognized with two EPA Scientific Achievement Awards and the Distinguished Service Medal from the U.S. Public Health Service. He is a Member of Consultations on the World Health Organization (WHO) Guidelines for Drinking Water Quality, serves on International Agency for Research on Cancer (IARC) Working Groups on the Evaluation of Carcinogenic Risks to Humans, and chaired the US EPA's Drinking Water Committee. Bull is author or co-author of more than 135 peer-reviewed publications, and has written reviews, books, and chapters relating to toxicology of drinking water contaminants. He is currently reviewing disinfection by-products for the Archives of Toxicology. Bull holds a B.S. in Pharmacy from University of Washington and a Ph.D. in Pharmacology from the School of Medicine at University of California, San Francisco.

Joseph A. Cotruvo, Ph.D., BCES, President, Joseph Cotruvo and Associates, LLC

Dr. Joseph Cotruvo has more than 45 years of experience with research and policy related to drinking water quality. He is a long-time member of the WHO's Guidelines for Drinking Water Quality Committee and serves on advisory panels for drinking water quality and desalination projects, including Singapore's National Environment Agency Water Standards Advisory Committee, the Nanyang Technical University Environment and Water Research Institute Advisory Board, and wastewater and potable water reuse projects in California including for Orange County, San Diego, and Los Angeles. At US EPA, Cotruvo directed the Drinking Water Standards Division, which developed national regulations and risk assessments for microbial contaminants, organic and inorganic chemicals and radionuclides, disinfection by-products, surface water filtration, and proposed corrosion control lead and copper rules. He also directed the Risk Assessment Division in Pollution Prevention and Toxics and initiated EPA's Drinking Water Health Advisory Program. Cotruvo holds a B.S. in Chemistry from University of Toledo and a Ph.D. in Physical Organic Chemistry from Ohio State University.

Thomas E. Harder, PG, CHG, Principal Hydrogeologist, Thomas Harder & Co.

Mr. Thomas Harder has more than 2229 years of professional groundwater consulting experience. He has provided technical direction and management for large water resource projects in southern California, including the Chino Desalter Well Field Design and Construction, the West Coast Basin Barrier Project, and the Mojave Water Agency's Regional Recharge and Recovery Project. His expertise includes regional groundwater basin analysis, perennial (i.e., safe) yield, artificial recharge, groundwater management and models, contaminant hydrogeology, and wells. Harder holds a

B.S. in Geology from California Polytechnic University, Pomona, and an M.S. in Geology with emphasis in Hydrogeology from California State University, Los Angeles. He is a registered geologist and hydrogeologist in California.

Adam Olivieri, DrPH, P.E., EOA, Inc.

Dr. Adam Olivier has more than 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 a number of positions, including: staff engineer with the California Regional Water Quality Control Board (San Francisco Bay Region); staff specialist and Post-doctoral fellow with the School of Public Health at University of California, Berkeley; project manager/researcher for the Public Health Institute; and as a consulting engineer. Dr. Olivieri is currently Vice President of EOA, Inc., in Oakland, California, where he manages a variety of projects, including serving as Santa Clara County Urban Runoff Program's Manager since 1998. He received a B.S. in Civil Engineering from University of Connecticut, an M.S. in Civil and Sanitary Engineering from University of Connecticut, and both an MPH and Dr.PH in Environmental Health Sciences from University of California, Berkeley.

Vernon Snoeyink, Ph.D., Professor Emeritus, Civil and Environmental Engineering, University of Illinois

Dr. Vernon Snoeyink's research has focused on drinking water quality control, including removal of organic and inorganic contaminants from water using adsorption systems, especially granular and powdered activated carbon systems coupled with membrane systems. His expertise includes mechanisms of formation and means to control water quality in distribution systems in response to reactions of iron, aluminum, and other inorganics. Snoeyink is a member of National Academy of Engineering, American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), Association of Environmental Engineering and Science Professors (AEESP), and International Water Association. He served as President of AEESP and on the Editorial Advisory Board of AQUA. His awards include the AEESP Distinguished Lectureship, the Research Award from AWWA, the Warren A. Hall Medal from the University Council on Water Resources, the Samuel Arnold Greeley Award and the Simon Freese Award from ASCE, the Thomas Feng Distinguished Lectureship from University of Massachusetts, and the Tau Beta Pi Daniel C. Drucker Eminent Faculty Award from University of Illinois. He has also been recognized for excellence in teaching and advising. He holds a B.S. in Civil Engineering, an M.S. in Sanitary Engineering, and Ph.D. in Water Resources Engineering from University of Michigan.

Michael K. Stenstrom, Ph.D., P.E., BCEE, Professor, Civil and Environmental Engineering, UCLA

Dr. Michael Stenstrom teaches courses in water and wastewater treatment, mathematical modeling of environmental systems, and laboratory analysis. His research focuses on improving oxygen transfer at wastewater treatment plants. Stenstrom has received the Harrison Prescott Eddy Research Award, the Science Coalition's Great Advances in Scientific Discovery Award, and the 2005 Water Quality Improvement Award from the California Water Resources Control Board. He completed his undergraduate and graduate studies in engineering at Clemson University, and he is a Registered Professional Civil Engineer in California and a Board Certified Environmental Engineer with the American Academy of Environmental Engineers.

Paul K. Westerhoff, Ph.D., P.E., BCEE, Professor, Sustainable Engineering/Built Environment, Arizona State University

Dr. Paul Westerhoff's research focuses on emerging contaminants, water treatment processes, and water quality, including: occurrence, characterization, and oxidation of natural organic matter; removal of oxo-anions from drinking water; algal metabolites and algal biotechnology; wastewater reuse; and nanotechnology and sensors. He was awarded the Editors' Choice Award for 2016 in Environmental Science: Water Research & Technology for the paper entitled N-Nitrosamine Formation Kinetics in Wastewater Effluents and Surface Waters. Westerhoff holds a B.S. in Civil Engineering from Lehigh University, an M.S. in Civil and Environmental Engineering from University of Massachusetts, Amherst, and a Ph.D. in Civil, Architectural, and Environmental Engineering from University of Colorado at Boulder. He is a Registered Professional Engineer in Arizona.

ATTACHMENT B: PANEL MEETING #1 AGENDA

**Independent Science Advisory Panel Workshop No. 1
 MWD Union Station Room 2-450
 August 8-9, 2018**

Timing	Topic	Presenter
August 8, 2018		
8:00 a.m.	Welcome and Introduction	NWRI/MWDSC/LACSD
8:15 a.m.	Regional Recycled Water Program	MWD/LACSD
9:15 a.m.	Defining ISAP Charge	NWRI
9:30 a.m.	Demonstration Plant Testing and Monitoring Plan	Stantec/Trussell/Carollo
10:30 a.m.	Break	All
10:45 a.m.	Monitoring Plan for JWPCP's Compliance	LACSD
11:30 a.m.	Luncheon	All
12:30 p.m.	Questions and Answers	All
2:45 p.m.	Break	All
3:00 p.m.	Closed Session	Panel Members
5:00 p.m.	Adjourn	
August 9, 2018		
8:00 a.m.	Panel Members Discussion (Room 2-414)	Panel Members
9:00 a.m.	Regulatory Meeting (Room 2-450)	All (Panel continues work)
11:00 a.m.	Luncheon	All
12:00 p.m.	Report by SAP/Next Steps (Room 2-414)	All
2:00 p.m.	Adjourn	

ATTACHMENT C: PANEL MEETING #1 ATTENDEES

Panel Members

- Panel Chair: Charles Haas, Ph.D., Drexel University
- Richard J. Bull, Ph.D., MoBull Consulting
- Joseph A. Cotruvo, Ph.D., BCES, Joseph Cotruvo and Associates
- Thomas E. Harder, PG, CHG, Thomas Harder and Co.
- Adam Olivieri, DrPH., P.E., EOA, Inc.
- Vernon Snoeyink, Ph.D., University of Illinois
- Michael K. Stenstrom, Ph.D., P.E., BCEE, University of California, Los Angeles
- Paul K. Westerhoff, Ph.D., PE, BCEE, Arizona State University

Panel Facilitator

- Ed Means, Means Consulting

National Water Research Institute

- Kevin M. Hardy, Executive Director
- Dawna Hernandez, Event Manager
- Suzanne Sharkey, Water Resources Scientist and Project Manager

Metropolitan Water District

- John Bednarski
- Richard Began
- Mickey Chaudhuri
- Heather Collins
- George DiGiovanni
- Jim Green
- Robert Harding
- Gordon Johnson
- Gloria Lai-Blüml
- Sun Liang
- Kimberly McGeeney
- Paul Rochelle
- Carolyn Schaffer
- Mic Stewart

Sanitation Districts of Los Angeles County

- Erika Bensch
- Lysa Gaboudian
- Joe Gully
- Ann Heil
- Michael Liu
- Nikos Melitas
- Mike Sullivan

Sanitation Districts of Los Angeles County

- Shawn Thompson
- Chris Wissman

State Water Resources Control Board

- Faraz Asad
- Brian Bernados
- Saeed Hafeznezami
- Sean McCarthy
- Jeff O'Keefe

Los Angeles Regional Water Quality Control Board

- Cris Morris
- Milasol Goslan
- Jeong-Hee Lim

Industry/Technical/Research Groups

- Zakir Hirani, Stantec
- Jeff Mosher, Carollo Engineers
- Paul Brown, PRB Inc.
- Adam Zacheis, Carollo
- Shawn Thompson, LACSD
- Shane Trussell, Trussell Technologies