



June 5, 2023

Paul Rochelle, PhD
Water Quality Section Manager
Metropolitan Water District of Southern California

**Subject: Advanced Purification Center Demonstration Project
NWRI Independent Science Advisory Panel Workshop
March 22–23, 2023**

Dear Dr. Rochelle:

The National Water Research Institute (NWRI) is pleased to present this report with the consensus findings and recommendations of the NWRI-administered Independent Science Advisory Panel (Panel), which supports the Metropolitan Water District (Metropolitan) of Southern California's Pure Water Southern California Advanced Purification Center Demonstration Project (Project). The Panel met on March 22–23, 2023; some attendees were on site at the Metropolitan Water District headquarters in downtown Los Angeles and others attended remotely via a Zoom link. Ed Means, Principal of Means Consulting and an NWRI subcontractor, facilitated the meeting.

The following Panel members attended the workshop:

- [Panel Chair: Charles Haas, PhD, BCEEM](#), Drexel University
- [Joseph A. Cotruvo, PhD, BCES](#), Joseph Cotruvo and Associates
- [Thomas E. Harder, PG, CHG](#), Thomas Harder and Co.
- [Nancy Love, PhD, PE, BCEE](#), University of Michigan
- [Adam Olivieri, DrPH, PE](#), EOA, Inc.
- [Vernon Snoeyink, PhD](#), University of Illinois
- [Paul K. Westerhoff, PhD, PE, BCEE](#), Arizona State University



Panel member [Paul Anderson, PhD](#), an Independent Consultant, did not attend. Biographical profiles of Panel members are on the NWRI website: www.nwri-usa.org.

More information about NWRI is included in Attachment 1. The workshop agenda is in Attachment 2, and a list of workshop attendees is in Attachment 3.

Meeting Objectives

Working collaboratively with NWRI, the Metropolitan Project Team established the following four objectives for the Workshop:

1. Discuss the results of the secondary MBR baseline testing up to the date of the workshop.
2. Discuss the proposed next steps after the MBR baseline testing.
3. Review Metropolitan's approach and thinking on direct potable reuse.
4. Allow time for the Panel to ask questions and begin drafting the Panel Meeting Report.

Questions Presented to the Panel

The Project Team presented the following questions for the Panel's consideration:

1. Does the Panel concur that the secondary MBR results, along with future results that will be collected during sMBR baseline testing, provide a future dataset that would:
 - a. Support future regulatory application for a >2.5 log credit for MBR?
 - b. Demonstrate the product water will be suitable for groundwater recharge in the proposed groundwater basins?
 - c. Characterize the impact of the RO concentrate stream on ocean discharge, and waste residual streams on JWPCP operations?
2. Based on secondary MBR testing results, or new information acquired since the last workshop, are there additional factors that should be considered by the Project Team in evaluating secondary MBR for potable reuse?
3. Based on information provided at the workshop, does the Panel support the proposed shift in testing approach to identify a feasible process train for the full-scale facility?
4. Based on the DPR updates, does the Panel support the testing approach to identify a process train for integration into the program?



General Comments

The Panel commends the Metropolitan Water District Project Team on the level of research effort, the quality of the results, and the straightforward presentations.

The Panel recognizes Metropolitan’s substantial effort to move the Project forward since the last workshop on January 5–6, 2022. The March 2023 workshop represents the Project Team’s updated work; and the Panel is generally satisfied with the information provided.

Panel Response to Questions

In this section, the Panel offers their opinions and recommendations in response to questions from the Project Team.

- 1. Does the Panel concur that the secondary MBR results, along with future results that will be collected during sMBR baseline testing, provide a future dataset that would:**

- a. Support future regulatory application for a >2.5 log credit for MBR?**

Response. Yes, with some cautions as noted below.

- The Panel believes the Project would benefit from a better understanding of the relatively poorer *Giardia* removal performance (*E. coli*, *Clostridium perfringens*, and endospores) in the DuPont membrane. Understanding and reporting specific membrane performance may help improve membrane design in the future.
- The Panel is concerned about the lack of and/or limited sampling from cut membranes and recommends that the Project Team explore this further. Additional challenge testing by cutting membrane fibers and analyzing membrane performance would offer useful information about how membranes should be designed or constructed and would help develop membrane specifications for the Project.

- b. Demonstrate the product water will be suitable for groundwater recharge in the proposed groundwater basins?**

Response: Yes, with the following suggestions.



- The Panel advises the Project Team to begin coordinating with regulators about the use of basin assimilative capacity for boron compliance to confirm conditions and to plan for that approach. These plans will be important if boron concentrations that are higher than the Basin Plan Objective are observed during pilot testing.
- The Panel believes that understanding when and how much boron loads might decline would benefit Project planning. The Boron Analysis report indicates that oil fields, which are the major source of boron, will be phased out over time and that a City of Los Angeles policy will prohibit new oil wells.
- The Panel notes that the rationale for establishing the nitrate target for final advanced water treatment (AWT) product water was explained well in the workshop presentation but could be documented more clearly in writing.
- The Panel looks forward to the additional testing that will be conducted on tertiary membrane bioreactor (MBR) treatment.

c. Characterize the impact of the RO concentrate stream on ocean discharge, and waste residual streams on JWPCP operations?

Response. Yes.

The Panel is interested in any future test results. The Panel notes that the State Water Board's 2023 updated Monitoring Strategies for Constituents of Emerging Concern (CECs) in California's Aquatic Ecosystems should be released soon.

2. Based on secondary MBR testing results, or new information acquired since the last workshop, are there additional factors that should be considered by the Project Team in evaluating secondary MBR for potable reuse?

Response. Yes, with additional Panel comments noted below.

- The Panel acknowledges the reduced nitrogen concentrations coming out of secondary MBR and encourages the Project Team to continue to find ways to reduce nitrogen in the RO concentrate by using processes such as denitrification or additional concentrate treatment. Nongovernmental organizations are putting pressure on the California State Water Resources Control Board to require full



nitrification/denitrification for discharges to the ocean and San Francisco Bay, based on the preliminary findings of the Southern California Coastal Water Research Project (SCCWRP) Regional Oceanic Model System–Biogeochemical Elemental Cycling (ROMS–BEC) modeling effort. Planning for and investing in nitrogen reduction is wise and will have multiple benefits. High purity oxygen results are encouraging; potentially significant impacts on alkalinity are noted.

- The Panel advises the Project Team to assess Haloacetonitrile concentrations in both RO influent and permeate because of formation at higher chloramine concentrations.
- The Panel suggests considering other disinfectants in various stages; for example, peroxyacetic acid (PAA) for membrane protection and bromine chloride for greater antimicrobial efficacy at lower doses in high amine environments. If PAA is used, however, some of it will break down and may produce acetic acid/acetate, which could pass through the membrane and increase the total organic carbon (TOC) concentration. The Project Team should keep this in mind when considering using PAA.

3. Based on information provided at the workshop, does the Panel support the proposed shift in testing approach to identify a feasible process train for the full-scale facility?

Response. Yes, with the following caveats:

The Panel understands the proposed shift in testing is from the current testing phase of nitrification/denitrification sMBR to proposed tMBR optimization testing. The Panel also understands the following broad project phases: Phase 1 is a 2032 target date for 115 million gallons per day (mgd) total capacity to address industrial and indirect potable reuse (IPR) demands of 90 mgd and direct potable reuse (DPR) demands of 25 mgd; Phase 2 is a target date beyond 2032, which will provide an additional 35 mgd capacity to meet DPR demands.

The Panel makes the following additional recommendations:



- The Project Team should define the plan to split flows and treatment to clearly show the various combinations of IPR and DPR flow and treatment alternatives. The Panel believes the format used for the presentation of DPR and IPR in the PowerPoint slides (slides starting with 173 and the example summary in slide 176) is a good way to present the evaluation of various combinations of flow and treatment and how they may relate to the associated monitoring and process operational assumptions. In addition, the Panel also suggests that the approach be expanded to cover the entire treatment train.
- The Project Team should clearly articulate what its decision rules and assumptions will be for secondary MBR and tertiary MBR. Define those factors and preferences up front.
 - The Panel notes that testing is sequential, with possible different feed water conditions and loads, which introduces some uncertainty in comparisons. The Panel understands the practical limitations of parallel testing.
 - The Project Team should articulate the post-RO stabilization strategy, considering influences on subsequent phases (if any).
 - The Project Team needs to resolve the snail growth issue and understand the impact, if any, on lifetime membrane performance. The Project Team should consider coordinating with membrane manufacturers regarding their experience with snail growth and should survey other MBR users for their experience and control measures.
 - The Panel is encouraged by the side stream centrate treatment evaluation that has been conducted and are interested to hear the Project Team's proposed next steps.

4. Based on the DPR updates, does the Panel support the testing approach to identify a process train for integration into the program?

Response. Yes, with the following comments:

- The Project Team should consider quantifying known carbon species and determining how much TOC is accounted for in the treatment train and final product



water and how much remains unknown. (This comment refers to previous Panel concerns with the fate of refractory organic carbon). Understanding this may allow the team to improve the design of AWT+ by targeting processes where additional TOC reduction could be optimized, if desired.

- The Project Team should consider simple modeling or ozone/hydroxyl radical organics destruction. Estimate the types of doses needed to remove pollutants to screen and exclude treatment processes—not for design purposes.
- The Project Team should continue to consider very frequent monitoring, which is an important element of a Hazard Analysis/Critical Control Point approach to process management. Emphasize real-time monitoring, where possible, for performance evaluations and, ultimately, for management of the full-scale process train.
- The Panel recommends that the Project Team consider the cost and value of monitoring for the whole suite of volatile organic compounds (VOCs), considering the information it provides. The list of VOCs is somewhat redundant, since benzene, chloroform, toluene, ethylbenzene, trimethyl benzenes, and tetrachloroethylene all have similar physical chemical properties and maximum contaminant levels (MCLs). Except for benzene, they are not particularly harmful for exposures that might occur during process upsets. Benzene would be the greater concern for longer and higher exposures. Acetone and formaldehyde are not very toxic and are both *in vivo* metabolites and are much more difficult to remove because of their high solubility in water. As such, they are a process performance measure that should be correlated with specific contaminants of concern or process variables. Precursors of nitrosamines such as dimethylamine and morpholine (morpholine is the mono nitrogen analog of 1,4 dioxane) are more important for removal at earlier stages.
- The Panel recommends adding nitrosamine precursors and process performance measures to the analytical suite, as the low molecular weight molecules dimethylamine and morpholine can pass through RO.
- The Panel would be interested in learning about the PFAS strategy that Metropolitan and Los Angeles County Sanitation Districts expect to use to manage this suite of



contaminants in treated water, solids, and RO concentrate and how process trains might affect those concentrations.

Additional Panel Comments about tMBR versus sMBR

In the Project Team presentation, slide 50 states that tMBR is the lowest cost, most reliable, and most constructable in five years and that it has flexibility for future nitrification/denitrification by adding carbon or conversion to secondary MBR. The basis for those conclusions is not obvious from the slides since a technically defensible parallel operating comparison between sMBR and tMBR was not available and most likely will not be available. The Panel recommends an objective comparison be done when full data sets are available.

Also, the Panel would appreciate clarification on overall costs and would like to know if the least cost statement refers to conventional secondary plus tMBR, or sMBR from conventional primary, or just incremental tMBR after conventional secondary treatment.

Conclusion

The Panel looks forward to continuing to work with the Metropolitan Project Team. If you have any questions or concerns, contact Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.

Sincerely,

A handwritten signature in blue ink, appearing to read "Charles Haas", with a long horizontal flourish extending to the right.

Dr. Charles Haas
Panel Chair



Attachment 1 • About NWRI

The National Water Research Institute is a 501c3 nonprofit and Joint Powers Authority that collaborates with water utilities, regulators, and researchers in innovative ways to help develop new, healthy, and sustainable sources of drinking water. We assemble teams of scientific and technical experts that provide credible independent review of water projects, develop recommendations that support investment in water infrastructure and public health, and enable water resource management decisions grounded in science and best practices.

NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Metropolitan Water District of Southern California, Orange County Sanitation District, and Orange County Water District.

Disclaimer

This report was prepared by an Independent Science Advisory Panel (Panel), which is administered by NWRI. The opinions, findings, conclusions, or recommendations expressed in this report reflect the Panel's consensus and were prepared by the Panel. This report was published for informational purposes.

For more information, please contact

National Water Research Institute
18700 Ward Street
Fountain Valley, California 92708 USA
www.nwri-usa.org

Kevin M. Hardy, Executive Director
Mary Collins, Communications Manager
Suzanne Sharkey, Project Manager



Attachment 2 • Meeting Agenda



Independent Science Advisory Panel for The Metropolitan Water District of Southern California Pure Water Southern California (PWSC) Program Agenda for Panel Meeting 6

March 22, 2023 11:00am – 3:00pm PDT; March 23, 2023 9:00am – 1:00pm PDT

Meeting Objectives

1. Discuss the results of the secondary MBR baseline testing up to the date of the workshop.
2. Discuss the proposed next steps after the MBR baseline testing.
3. Review Metropolitan’s approach and thinking on direct potable reuse.
4. Allow time for the Panel to ask questions and begin drafting the Panel Meeting Report.

Schedule for March 22, 2023

Time	Topic	Speaker/Presenter(s)
10:45 a.m.	Panel member login and audio/video test	
11:00 a.m.	Welcome and introductions, logistics, review meeting agenda and Panel charge	Ed Means, Panel Facilitator
11:10 a.m.	Introduction and program updates	Metropolitan
11:30 a.m.	Nitrogen management and next steps	LACSD and Metropolitan
12:10 p.m.	Panel questions and discussion	Ed Means
12:20 p.m.	Working lunch	
12:30 p.m.	Secondary MBR Test Results <ul style="list-style-type: none"> • Testing overview • Unit process operations and performance • Pathogen and indicator microbes 	Metropolitan and Consultants
1:40 p.m.	Panel questions and discussion	Ed Means
2:00 p.m.	Break	
2:15 p.m.	Closed Panel working session	Ed Means and Chuck Haas, Panel Chair
3:00 p.m.	Adjourn Day 1	



Schedule for March 23, 2023

Time	Topic	Speaker/Presenter(s)
8:45 a.m.	Panel member login and audio/video test	
9:00 a.m.	Welcome and review agenda	Ed Means, Facilitator
9:05 a.m.	Secondary MBR test results <ul style="list-style-type: none"> • RO concentrate characterization 	LACSD
9:30 a.m.	Panel questions and discussion	Ed Means
10:00 a.m.	DPR overview and approach	Consultants
10:30 a.m.	Break	
10:40 a.m.	DPR overview and approach (cont.)	Consultants
11:40 a.m.	Panel questions and discussion	Ed Means
12:10 p.m.	Closed Panel working session	Ed Means and Chuck Haas, Panel Chair
1:00 p.m.	Adjourn Day 2	

Questions for the Panel

- 1) Does the Panel concur that the secondary MBR results, along with future results that will be collected during sMBR baseline testing, provide a future dataset that would:
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Contacts, National Water Research Institute

- Ed Means, Facilitator (949) 439–9120
- Kevin Hardy, Executive Director (760) 801–9111
- Suzanne Sharkey, Project Manager (949) 258–2093



Attachment 3 • Workshop Attendees

The March 22–23, 2023, workshop included in-person attendees at the Metropolitan Water District headquarters in Los Angeles and remote attendees via a Zoom link.

March 22

Ginachi Amah

Faraz Asad

John Bednarski

Erika Bensch

Brian Bernados, California Water Resources Control Board

Jim Borchardt

Norman Bradley

Amos Branch, Carollo Engineers

Suzanne Brown

Rajen Budhia, Metropolitan

Peter Carlstrom

Bruce Chalmers, Metropolitan

Mickey Chaudhuri

Connie Christian

John Chung

Heather Collins, Metropolitan

Joe DeMel

Eric Dickenson, SNWA

George DiGiovanni

Zeynap Erdal, Black & Veatch

Syljohn Estil

Emi Fujii, Metropolitan

Lisa Gaboudian, LACSD

Dan Gerrity, SNWA

Carrie Guo

Matt Hacker, Metropolitan



Nan Harrold

Jeong-Hee Lim

Zakir Hirani

Anna Hockensmith

Ai Jia

Malika Jones

Jayne Joy

Gloria Lai-Bluml, Metropolitan

Steven Lajkowicz

Julio Lara

Joyce Lehman, Metropolitan

Michael Liu

Maria Lopez

Ajay Mallik

B Mansell

Kristopher McGinnis

Nikos Melitas

Chris Mendoza

Lindsay O'Donahue

Perry Palencia

Karamjit Panesar

Sejal Patel, LACSD

Jennifer Quach-Cu, LACSD

Paul Rochelle, Metropolitan

Alan Ronn

Andy Salveson, Carollo Engineers

Monica Sanchez, LACSD

Terri Slifko

Mike Sullivan

Paul Swaim

Adam Taing

Shawn Thompson



Martha Tremblay

Ray Tremblay

Shane Trussell

Don Tsai

Steven Webb

Greg Wetterau

Kim Wilson

NWRI Panel Members

Chuck Haas, PhD, Panel Chair

Joe Cotruvo, PhD

Thomas Harder, PhD

Nancy Love, PhD

Adam Olivieri, DrPH

Vern Snoeyink, PhD

Paul Westerhoff, PhD

NWRI Staff and Consultants

Kevin Hardy

Ed Means, Independent Consultant/Meeting Facilitator

Mary Collins

Tianna Manzon

Suzanne Sharkey

March 23

Ginachi Amah

Yamrot Amha

Brian Bernados, California Water Resources Control Board

Jim Borchardt

Amos Branch, Carollo Engineers

Misty Brown

Suzanne Brown



Peter Carlstrom
Connie Christian
Heather Collins, Metropolitan
Eric Dickenson, SWNA
George DiGiovanni
Zeynep Erdal
Syljohn Estil
Dan Gerrity, SNWA
Carrie Guo
Tyler Hadacek
Nan Harrold
Zakir Hirani
Anna Hockensmith
Ai Jia
Steven Lajkowicz
Joyce Lehman
Michael Liu
Maria Lopez
Ajay Malik
B Mansell
Sean McCarthy
Nikos Melitas
Chris Mendoza
Lindsay O'Donohue
Karamjit Panesar
Jennifer Quach-Cu, LACSD
Paul Rochelle
Alan Ronn
Andy Salveson, Carollo Engineers
Terri Slifko
Adam Taing
Martha Tremblay



Ray Tremblay

Shane Trussell, Trussell Technologies

Don Tsai

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Kim Wilson

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