



Memorandum

Date: August 3, 2022

To: Wendy Steffensen
Environmental Project Manager, LOTT Clean Water Alliance

From: James Crook, PhD, PE, Panel Chair
Kevin M. Hardy, JD, Executive Director, NWRI

Subject: NWRI Independent Expert Advisory Panel for LOTT RWIS
Panel Meeting 7 Recommendations

NOTE: The LOTT Study Team received a draft of this memorandum on July 29, 2022. This memo contains their responses to the Panel comments, which are noted in blue throughout the document.

The National Water Research Institute (NWRI) is pleased to provide this memorandum from the NWRI Peer Review Panel to review the LOTT Clean Water Alliance Reclaimed Water Infiltration Study (RWIS) project. The Panel met online on July 6, 2022, to review presentations on the Cost Benefit Analysis from the LOTT study team.

The purpose of the NWRI Panel was to provide a third-party peer review of the technical, scientific, regulatory, and policy aspects of the RWIS project. Results of the study will be used to help policymakers make informed decisions about reclaimed water treatment and use in the future.

NWRI Peer Review Panel Members

- Chair: James Crook, PhD, PE, BCEE, Environmental Engineering Consultant
- Paul Anderson, PhD, ARCADIS
- Michael Dodd, PhD, University of Washington
- Michael Kenrick, PE, LHG, GeoEngineers, Inc.

Kevin M. Hardy • Executive Director • khardy@nwri-usa.org • www.nwri-usa.org

JPA MEMBERS: 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 • Orange County Water District



- Edward Kolodziej, PhD, University of Washington
- John Stark, PhD, Washington State University

More information about NWRI is provided in Appendix A and biographical information about the Panel members is in Appendix B. The agenda for the meeting is in Appendix C. A list of meeting attendees is in Appendix D.

Pre-Meeting Review Materials

The Panel thanks the LOTT study team for providing the following excellent project materials to review before the meeting:

- Cost/Benefit Analysis (Task 4) for RWIS, prepared by HDR (March 23, 2022).
- LOTT Clean Water Alliance Reclaimed Water Infiltration Study Project Summary DRAFT, prepared by HDR (July 5, 2022).

Panel Findings and Recommendations

The principal findings and recommendations of the Panel are based on the presentations about the Cost Benefit Analysis and the draft RWIS Project Summary that were given by the study team at Meeting 7 on July 6, 2022. The Panel appreciates the high quality of the study team's presentations and pre-meeting review materials.

The Panel was given three questions. The following section lists the questions that LOTT provided, followed by Panel responses and recommendations.

Technical Review Questions and Responses

1. Do you agree with the revisions made to the Cost Benefit Analysis (CBA) that further explore the use of GAC as a treatment option?

Yes, in general the Panel agrees with the revisions that the LOTT Study Team made to the Cost Benefit Analysis, with a few additional recommendations.

For example, the LOTT study team has done a good job addressing the potential benefits of granular activated carbon (GAC) treatment for mitigating *N*-nitrosodimethylamine (NDMA) levels. The Cost Benefit Analysis addresses the need for more extensive monitoring of NDMA precursors and pre-existing NDMA in influent wastewater at the Martin Way and Budd Inlet facilities. This analysis should enable a more informed assessment of the contributions of (a) pre-existing NDMA in influent wastewater and (b) NDMA formation during disinfection, to NDMA levels in reclaimed water. The resulting information will facilitate assessment of the corresponding degree to which GAC may help to mitigate those contributions.



In addition to perfluoroalkyl substances (PFAS), the *N*-nitrosamines are one of the *groups* of contaminants relevant to water reuse that are frequently considered as candidates for future regulation. However, NDMA may account for only a small fraction of the total *N*-nitrosamine levels in reclaimed water (see the EPA's technical support document from the most recent six-year review of existing drinking water standards:

<https://www.epa.gov/sites/default/files/2016-12/documents/810r16009.pdf>).

As part of ongoing monitoring efforts, the Panel also recommends that the LOTT study team consider expanding monitoring to encompass the five other *N*-nitrosamines included in the EPA's draft Contaminant Candidate List v5, or a subset thereof, based on available analytical capabilities (see: <https://www.epa.gov/ccl/draft-ccl-5-chemical-disinfection-byproducts-group>). Similar to the case of PFAS, the resulting data would facilitate assessment of potential additive effects on risk of multiple *N*-nitrosamine compounds and would provide a more comprehensive picture of potential risks associated with the *N*-nitrosamines as a class.

Study Team Response: We appreciate the input and recommendations regarding monitoring the wider class of nitrosamines. LOTT will use this input when developing future monitoring plans.

The Panel also noted in reviewing the Cost Benefit Analysis that the changes to estimated risks associated with NDMA, NDMA precursors, and PFAS summarized in Table 7 and Figures 1 and 2 appear to be based on assumptions of the maximum removal levels reported for the advanced treatment options that were evaluated. To better evaluate the efficacy of each treatment option and its associated benefits, and to provide a more conservative basis for assessing such benefits, the Panel instead recommends providing a range of post-treatment estimated risks in Table 7 and Figures 1 and 2. The range should be based on assumed removal efficiencies ranging from the minimum to maximum levels listed in Table 1 of the Cost Benefit Analysis (when variable levels are provided), rather than only on the maximum assumed removal efficiencies.

Study Team Response: We concur that showing the data this way is more consistent with the conservative (health protective) nature of the assessment. We will revise the table as noted.

2. As a Project Summary, is this outline complete? Does the draft accurately summarize the overall effort? Any suggestions for improvement?

The Panel believes the draft Project Summary accurately summarizes the overall effort.

The Panel recommends that the discussion about the EPA's recent draft Drinking Water Health Advisory for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in Section 8.0 of the draft Project Summary indicate that the recommended levels are



substantially lower than the drinking water equivalent levels (DWELs) used in the Human Health Risk Assessment (HHRA). If adopted, the recommendations may result in maximum contaminant levels (MCLs) that are also substantially lower than the DWELs.

Study Team Response: The team concurs and will revise the discussion as noted.

3. This is the final Panel meeting and review of the materials for the Reclaimed Water Infiltration Study. Does the Panel have any final thoughts about the process or the study that you would like to share?

As LOTT moves forward with the RWIS project, the Panel recommends that the study team monitor the rapidly changing science around the potential effects of PFAS in drinking water and the rapidly changing regulatory environment to mitigate those potential effects. A recent example of such rapid changes is EPA's recently released draft Drinking Water Health Advisory level for PFOA of 0.004 nanograms per liter (ng/L), which is an extremely low concentration that is not analytically detectable at this time. These evolving PFAS standards will likely govern LOTT decisions for additional treatment.

Study Team Response: Comment noted.

Based on these recent draft regulations, which are still subject to revision and final approval, it seems likely that EPA is going to reduce drinking water standards for PFOA, PFOS and perhaps other PFAS compounds to concentrations that are substantially lower than current allowable drinking water concentrations. While final regulations remain uncertain, a decrease to 0.01 ng/L or lower would not be unexpected given the draft Drinking Water Health Advisory level of 0.004 ng/L for PFOA. Because of these uncertainties and other factors that affect LOTT's decisions about potential treatment needs, the Panel does not have a specific recommendation at this time. However, the Panel does have some observations for LOTT's consideration as it deals with the changing science and regulations regarding PFAS in drinking water.

Treatment options. As demonstrated in the Cost Benefit Analysis, GAC is expected to greatly reduce PFAS concentrations, NDMA precursors, and other unregulated contaminants. However, at this time the Panel is unaware of a demonstration that GAC or any other treatment option can reduce PFOA concentrations enough to meet EPA's recently released draft Drinking Water Health Advisory level of 0.004 ng/L. We mention this because, in response to a question from the Panel, LOTT indicated that the marginal cost of adding GAC to the treatment train may be substantial, although less expensive than other treatments that were evaluated. The need for alternative or additional treatment technology will depend on the final regulatory standards.

Funding options. If the decrease in the PFOA drinking water standard is as substantial as indicated by the recent draft Drinking Water Health Advisory, virtually all water utilities in



the United States will be affected and will require additional treatment. This will place a large burden on customers of those utilities. Given the widespread nature of that economic burden, it is possible that either federal or state governments will make funds available for enhanced treatment.

Background concentrations. HDR's modeling uses a PFOA concentration in groundwater of about 15 ng/L as a result of reclaimed water infiltration without additional treatment and 0.15 ng/L assuming additional treatment is incorporated. HDR's modeling was of the incremental increase in PFOA concentration associated with infiltrated water, which assumes that the reclaimed water is the primary source of PFAS to this groundwater system. If there are background concentrations of PFAS in the ambient groundwater, it may make sense to understand the relative importance of the various sources contributing to the groundwater concentrations and mitigate the largest sources first instead of focusing solely on PFAS in infiltrated reclaimed water.

Study Team Response: We appreciate this input. LOTT will keep these considerations in mind as new information becomes available.

Conclusion

The purpose of the NWRI Panel was to provide an independent, third-party expert peer review of the technical, scientific, regulatory, and policy aspects of the LOTT RWIS project.

The Panel thanks the Study Team for the meeting presentations and response.

Please direct questions to Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.



Appendix A • About NWRI

Disclaimer

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

About NWRI

A 501c3 nonprofit organization, 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, Metropolitan Water District of Southern California, Orange County Sanitation District, and Orange County Water District.

For more information, please contact:

National Water Research Institute
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Appendix B • Panel Member Biographies

Chair: James Crook, PhD, PE, is an environmental engineer with more than 45 years of experience in state government and consulting engineering arenas, serving public and private sectors in the United States and abroad. He has authored more than 100 publications and is an internationally recognized expert in water reclamation and 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. 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 WaterReuse Association's 2005 Person of the Year. In 2016 he received the California WaterReuse Presidential Award. Crook received both an MS and PhD in Environmental Engineering from the University of Cincinnati, and a BS in Civil Engineering from University of Massachusetts.

Paul Anderson, PhD, is a Principal Scientist for ARCADIS US, Inc. Since 2000, Paul Anderson has researched the presence and effects of pharmaceutical ingredients and personal care products in surface water. His research began with developing a screening level model that predicts the concentration of human pharmaceuticals and other compounds released from wastewater treatment plants. He helped develop a database that summarizes peer-reviewed literature on aquatic toxicity, environmental fate in surface water, and treatment plant removal of pharmaceuticals. Anderson has more than 35 years of experience in human health and ecological risk assessment. He has a PhD and an MA in Biology from Harvard University and a BA in Biology from Boston University.

Michael Dodd, PhD, is an Associate Professor in the Department of Civil and Environmental Engineering and an Adjunct Associate Professor in the Department of Environmental and Occupational Health Sciences at the University of Washington (UW). Dodd's research focuses on characterizing chemical and photochemical redox processes in aquatic systems, particularly in eliminating pollutants and pathogens during water and wastewater treatment. Focus areas include modeling the behavior of chemical and microbiological contaminants during chemical oxidation and disinfection processes, developing assays to quantify the impacts of such processes, and engineering novel approaches to centralized and decentralized water treatment. Dodd has a PhD in Environmental Sciences from the Swiss Federal Institute of Technology-Zurich (ETH-Zurich), an MS in Environmental Engineering and a BS in Civil Engineering from Georgia Institute of Technology.

Michael Kenrick, PE, LHG, is Senior Consultant Hydrogeologist with GeoEngineers in Redmond, Washington. Since the Covid pandemic, Kenrick has been working remotely from his new home in Devon, England. His expertise includes aquifer hydraulics, well testing;



groundwater modeling; infiltration, flow and seepage; percolation and recharge; groundwater chemistry and quality; and water rights assessments. Kenrick trained as a civil engineer and hydrogeologist and has applied knowledge from a career serving commercial and municipal clients in key water-related sectors including groundwater, water supply, stormwater infiltration, artificial recharge, water reuse, dewatering for the mining and construction industries, and environmental assessment. He gained experience in the UK, Europe, Africa, and Asia before moving to Seattle in 1985, where he honed hydrogeologic methods for groundwater issues in the Pacific Northwest.

Edward Kolodziej, PhD is Associate Professor at the University of Washington, where he holds joint appointments in the Division of Sciences and Mathematics (UW Tacoma) and the Department of Civil and Environmental Engineering (UW Seattle). He works on a variety of local and regional water quality issues, especially those focused on organic contaminants, through The Center for Urban Waters in Tacoma, WA. Kolodziej's interests include water quality and contaminant fate in natural and engineered systems, especially focusing on interdisciplinary approaches to complex environmental issues affecting water and ecosystem health. His research has been published in *Science*, and featured in news media such as *Nature*, *Scientific American*, *U.S. News and World Report*, *Yahoo Health News*, *BBC Radio's "Inside Science"*, and the *Huffington Post* among others. Kolodziej earned an MS and PhD in Environmental Engineering at University of California at Berkeley, and a BS in Chemical Engineering from the Johns Hopkins University.

John Stark, PhD is a Professor of Ecotoxicology and Director of the Washington Stormwater Center at the Washington State University Research and Extension Center in Puyallup. His research addresses the development of hazard and risk assessment for aquatic organisms in rivers and streams in the Pacific Northwest. Stark is an expert in population modeling and has developed population-level risk assessments based on matrix and differential equation models. Recent projects involve determination of the effects of stormwater on salmon, zebra fish, and aquatic invertebrate health and assessing the impact of pesticides on endangered butterflies. Stark holds a PhD in Entomology and Pesticide Toxicology from University of Hawaii, an MS in Entomology from Louisiana State University, and undergraduate degrees in biology and forest biology from S.U.N.Y. and Syracuse University, respectively.



Appendix C • Meeting Agenda



Independent Expert Advisory Panel for LOTT Clean Water Alliance Reclaimed Water Infiltration Study

Meeting 7

July 6, 2022

Location

Zoom
See Outlook invite for login information

Contacts

Suzanne Sharkey: 949.258.2093
Mary Collins: 206.380.1930

Meeting Objectives

- Update the Panel on the draft final Cost Benefit Analysis and draft Project Summary
- Facilitate interaction between the Panel, the LOTT project team, and the Science Task Force
- Allow time for the Panel to begin drafting their final report on the study effort

OPEN STAKEHOLDER WORKSHOP: 12:00 to 1:15 p.m.

12:00 p.m.	Welcome, introductions, and review meeting objectives and agenda	Kevin Hardy, NWRI, and Jim Crook, Panel Chair
12:10 p.m.	Reorientation to project and timeline	Wendy Steffensen, LOTT
12:15 p.m.	Cost Benefit Analysis	Jeff Hansen, HDR
12:40 p.m.	Project Summary	Jeff Hansen, HDR
1:00 p.m.	Panel Q & A	Facilitated by Jim Crook
1:15 p.m.	Wrap up with Science Task Force	

CLOSED PANEL WORKING SESSION: 1:15 to 2:00 p.m.

1:15 p.m.	Closed Panel working session	Facilitated by Jim Crook
2:00 p.m.	Adjourn	

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NWRI Independent Expert Advisory Panel

- Chair: James Crook, PhD, PE, Environmental Engineering Consultant (Boston, MA)
- Paul Anderson, PhD, ARCADIS US, Risk Assessment Consultant (Chelmsford, MA)
- Michael Kenrick, PE, LHG, GeoEngineers (Redmond, WA)
- Edward Kolodziej, PhD, University of Washington (Tacoma, WA)
- Mike Dodd, PhD, University of Washington (Seattle, WA)
- John Stark, PhD, Washington State University (Puyallup, WA)

RWIS Project Team

- Lisa Dennis-Perez, LOTT
- Joanne Lind, LOTT
- Wendy Steffensen, LOTT
- Jeff Hansen, HDR
- Shane McDonald, HDR
- Brittany Duarte, HDR
- Gretchen Bruce, Intertox
- Kate McPeck, Windward Environmental

Science Task Force

- Peter Brooks, City of Lacey
- Erin Conine, City of Olympia
- Carrie Gillum, City of Tumwater
- Kevin Hansen, Thurston County
- Erik Iverson, City of Lacey
- Mallory Little, Washington State Department of Health
- Erica Marbet, Squaxin Island Tribe
- Hans Qiu, Washington State Department of Ecology
- Dan Smith, City of Tumwater
- Art Starry, Thurston County
- James Watt, Washington State Department of Health

National Water Research Institute

- Kevin M. Hardy
- Mary Collins
- Suzanne Sharkey



Appendix D • Meeting Attendees

LOTT Study Team and Science Task Force

Peter Brooks
Gretchen Bruce
Erin Conine
Lisa Dennis–Perez
Carrie Gillum
Jeff Hansen
Kevin Hansen
Joanne Lind
Mallory Little
Art Starry
Wendy Steffensen
Brian Topolski
James Watt
Tyle Zuchowski

Community Members

Bob Jacobs
Vladimir Nekrutenko
Ed Steinweg

NWRI Panel Members

James Crook, Panel Chair
Paul Anderson
Michael C. Dodd
Edward Kolodziej
John Stark

NWRI Staff

Kevin Hardy, Executive Director
Suzanne Sharkey, Project Manager
Mary Collins, Communication Manager