Memorandum

Date: September 3, 2021

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 Peer Review Panel for LOTT RWIS Panel Meeting 4 Recommendations

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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 June 21, 2021, to view presentations from the LOTT RWIS project team.

The purpose of the NWRI Panel is to provide a third-party peer review of the technical, scientific, regulatory, and policy aspects of the RWIS project, which LOTT is conducting to gather local scientific data and community input. Results of the study will be used to help policymakers make informed decisions about reclaimed water treatment and use in the future. More information about NWRI is in Appendix A.

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

More information about the Panel members is in Appendix B.

Pre-Meeting Review Materials

The Panel thanks the project team for providing the following excellent project materials for review before the June 21 meeting:

- Residual Chemical Fate and Transport Analysis (Task 2.1.5) DRAFT Technical Memorandum (HDR, June 11, 2021)
- Work Plan: Groundwater Modeling Predictive Simulations (Task 2.1.4 continued) and Residual Chemical Fate and Transport (Task 2.1.5) (HDR, February 20, 2020)
- 2020 Field Investigation Report [Appendix A to DRAFT Technical Memorandum Residual Chemical Fate and Transport Analysis (Task 2.1.5), June 11, 2021] (HDR, June 15, 2021)
- Human Health Risk Assessment, Preliminary Draft (Intertox, June 11, 2021)
- Ecological Risk Assessment, Partial Draft (Windward Environmental, June 11, 2021)

Panel Findings and Recommendations

The principal findings and recommendations of the Panel are based on the material presented by the project team at Meeting 4 on June 21, 2021. The agenda for the meeting is in Appendix C. The Panel appreciates the high quality of the project team's presentations and reports. Following are the Panel's recommendations and findings. NOTE: Blue text that follows the Panel's comments is LOTT's response to the Panel.

Hydrogeologic Study/Fate and Transport Analysis

- The Panel is concerned that the attenuation factors (AFs) are high-biased and are being skewed by the AFs modeling approach. The Panel believes the AFs are often overestimates, largely driven by the regression fit being forced through the origin for slow-decaying compounds. The short (120-day) time scale of the data set does not provide sufficient opportunities for slow decay process data points at long time scales to pull the regression down from the many early data points, which are—essentially—overweighted. The combination of these factors is causing AFs to be overestimated; primidone is a clear example. Does the regression model observed loss well, which seems minimal to non-existent over the data series?

  The data points also are poorly spaced over time for regression analysis, so some data points have disproportionate effects on fit (the origin to the left and the ~80- and 110-day points to the right). For some compounds, AFs are based on very few real data points and, therefore, are highly uncertain. The Panel recommends reconsidering this approach, likely with means to exclude the origin (assumed data point) from the regression analysis and potentially using weighting factors to better address data distributions.

- The Panel welcomes alternative visualizations or more explanation/clarity on exactly what is being presented in the LOTT Fate and Transport Analysis Appendix B data to derive AFs regressions. Specifically, the Panel has focused on the regression fits shown on pages 39 and 40 of that report and would like to be confident about what data are there and how the regressions were derived. At no point did the Panel believe these were concentrations, but we may still misinterpret their meaning/presentation and relationship to AFs modeling.
- Based on the provided captions "fraction of C/Co attenuated," which the Panel interprets basically as percent removal in decimal form, we are concerned about regression inaccuracy/poor fit for at least some of the chemicals.
- The Panel also remains highly skeptical that the origin should remain within the regressions fit to force the line. The removal processes explaining these data are not necessarily linear with travel time, and the resultant origin bias has the potential to introduce substantial skew into the AFs modeling at longer travel times. In particular, the Panel would like to be confident that the AFs regressions fit the primidone, TCEP, and TDCPP data well, among others.
- A related concern about forcing AFs fit through the origin for a given chemical is that the regressions then appear to become particularly sensitive to the value selected to represent the reclaimed water concentration for that chemical at the origin. If the value selected is especially high (as it looks like may have been the case for carbamazepine and TDCPP in Appendix B), it seems like it could have the effect of artificially elevating the values in the Model Predicted column, which would in turn elevate the AFs values at each sample point (due to the increase in denominator in the 1-observed/predicted expression). If this is the case, wouldn't it ultimately result in an overly large, calculated change from the origin to the measurement points, and AFs values that are biased high?
- Given the data, the Panel agrees that empirical data modeling from this system is more appropriate than a mechanistic approach based on chemical properties. However, some of the scattered and fragmentary data will make modeling difficult.
- Another possibility not accounted for by the use of the linear regression approach to obtain single (constant) AFs for a given compound is that attenuation over distance traveled, whether due to sorption or transformation processes, may vary considerably through the aquifer(s), for example, due to variations in media organic carbon content/character and/or redox conditions. In other words, attenuation may vary non-linearly with distance from source.

- While the Panel agrees that the use of a linear regression may be conservative and underestimate losses occurring within regions closer to the source, it may likewise significantly overestimate continued removal further from the source. This appears to be the case from the fits to the primidone and TDCPP data, for which continued removal at sample points exhibiting longer travel times than MW-5 appears to occur much more slowly than indicated by the AFs value obtained from linear regression of the data. In such cases, it may be worth exploring the use of an alternative empirical fitting approach (e.g., exponential or logarithmic) that can better account for such non-linearity.

  LOTT: Agreed that the processes may vary along the transport path; however, even a mechanistic model will not have the benefit of knowing how it varies along the path unless data are collected to support those variations. The AFs calculations use the actual in-aquifer concentrations along known and measured flow paths (remember, the conservative time of travel to each monitoring well is known through bromide tracer testing), so such variability *is* included in the empirical data. The linear regression is the simplest and most conservative approach (for the most part, the data show degradation occurring faster than the linear regression and a better fit equation, *e.g.*, exponential, would only show degradation occurring faster, not slower).

- The Panel also recommends that—if not already accounted for—uncertainties in measured compound concentration values be accounted for explicitly in the regression analyses either through: (a) error propagation/weighted regressions, or (b) pooled regressions of all discrete data points from replicate measurement series, rather than performing regressions on mean values without accounting for the uncertainties implicit in the means.

  LOTT: We can work with our statisticians to develop better fit regressions that include accounting for uncertainty; however, the analyses done for compounds where AFs were used trend toward Type I errors and avoid Type II errors. The EPCs calculated by this method overpredict the concentration that will arrive at the receptor, so if these residual chemicals are ruled out by the risk assessors, additional analyses are not really warranted.

- Please check regressions with residuals plots to assess the potential for bias.

  LOTT: See previous response. It is acknowledged that the regressions are biased towards Type I errors. This results in a conservative analysis, where if any residual chemicals are not excluded by risk assessment, further evaluation through mechanistic models can be done to further refine the EPC, but if the residual chemical is screened out at this level, no further analyses are needed.

- The Panel also notes that it can be reasonable to expect that some concentrations of residuals increase rather than decrease over time, potentially addressing the negative concentrations mentioned in the AFs modeling discussion. Apparent formation of residual chemicals can arise from uncertainties in input concentration (C0 estimated lower than actual, temporal variations in C0) as well as apparent formation processes for certain residual chemicals that can plausibly arise from deconjugation and transformation processes. This might be especially true for PFAS, where some monitored PFAS compounds are formed from higher-molecular-weight precursors during treatment or groundwater transport.

LOTT: Agreed. Risk assessment for PFAS and other compounds where AFs showed increases were based on the initial concentration multiplied by the C/C_0 arriving at the receptor.

- The Panel was somewhat concerned that a relatively simplistic approach was used for transport modeling; the attenuation factor approach glossed over sorption and other transport/decay parameters by lumping all such processes together into a single empirical parameter. While this approach has clear merits and simplicity is valued, can the project team provide justification for not using a more mechanistic modeling approach based upon K_D, f_{oc}, and K_{oc} and potentially reported biodegradation half-lives, as appears to have been considered in the original work plan for Tasks 2.1.4 and 2.1.5?

LOTT: We disagree that the method used is "simplistic": it involved conducting a year-long tracer test, building a detailed complex flow model that agrees with the tracer test, and then modeling a conservative tracer with advection and dispersion to match the tracer test as well, and then simulating the tracer into the future. Once arrival times were estimated at distant locations, the AFs based on empirical data from the site along with the modeled future cast were used to calculate some (not all) of the potential EPC. The model run time necessary to simulate the conservative tracer as C/C_0 with only advection and dispersion was about 110 hours. This method was used to screen out almost all the residual chemicals. If each residual chemical had been individually simulated, the combined run times likely would be prohibitive (note that adding decay and sorption only increase run time). Any residual chemical not screened out by this method can be simulated with the same model with the addition of decay/production and sorption (and dual domain porosity).

- Could the project team incorporate septic system locations into the project information, perhaps as an overlay on certain maps, or point the Panel to that information if it already exists in supporting documents (for example, in the original project info showing existing wells and private wells, such as in the characterization tech memos from Task 1)? Currently, red wells indicate extraction wells; for private residences, red wells also likely indicate septic systems as potential sources of some residual chemicals.

LOTT: We have indicated on maps in previous deliverables the properties that have septic systems. We will incorporate this information either in maps associated with the Task 2.1.5 TM or in project summary documents compiled at the end of the study.

- The description of Category 2 compounds indicates that such compounds were so designated when "These residual chemicals were detected in offsite monitoring wells, but AFs were not calculated due to insufficient data by which to arrive at an AFs (given the methodology described in Section 3.4), and/or the data indicate strong persistence." Does this mean that there were some Category 2 compounds for which there simply was not enough data to assess attenuation, but for which attenuation may have occurred or been anticipated to occur, and others for which there *was* sufficient data but for which no attenuation was observed? Or does it mean that in all cases insufficient attenuation was observed with the available data to determine attenuation factors? If the former, as the use of "and/or" seems to imply, it would be helpful to see Category 2 compounds split into two groups: (a) ones with insufficient data to ascertain persistence, versus (b) those with sufficient data and for which no clear attenuation was observed. This would be especially helpful for the group of PFAS and for NDMA.

  LOTT: We can split them into two groups. However, the method used to evaluate them (using the initial concentration multiplied by the C/C_0 EPC) was the same for both types of residual compounds.

- Should the City of Lacey add the Betti well to the monitoring program? Why are some wells out of scope or not part of Task Orders? The Panel recognizes the implications of residual chemical modeling for the Lacey Betti well, but likely needs additional insight into why the scope of work was originally constrained to not include the Lacey Betti well analysis to make an informed recommendation.

  LOTT: Data from various monitoring wells at distances away from the Hawks Prairie infiltration site have already been sampled. There is no plan to continue monitoring at this time. Should additional sampling occur, the Betti well could be added at the City of Lacey's discretion.

  The placement of the three original deep wells was based on what was known about the flow of groundwater in the deep aquifer at the time. The three additional deep wells were drilled to fill in data gaps and they were also paired with a shallow well.

  Additionally, the Betti Well was not included in the original scope because the work was focused on general conclusions regarding reclaimed water, not on specific drinking water wells, of which the Betti well is an example. The study design relies on sampling monitoring wells and predicting the concentration of residual chemicals at varying distances away from the infiltration site. The amount of residual chemical that arrives at the Betti well or any drinking water well can be inferred by the monitoring and modeling work done in the vicinity of that well, without targeting

any specific drinking water well. The study design takes the conservative/protective approach of utilizing points of maximum concentration along modeled flow paths as the basis for screening and further evaluation of potential human health and ecological risk. This approach evaluates "worst-case" risk scenarios, rather than evaluating risk at each potential receptor (of which the Betti well is only one). In this way, if the residual chemicals are ruled out by the risk assessors, additional analyses that are specific to a certain receptor, such as the Betti well, are not warranted.

- Is there past monitoring data for the Betti well?

  LOTT: The City of Lacey monitors the well in accordance with State Department of Health requirements. As such, there is limited monitoring data regarding many of the residual chemicals, as they are not included in routine water quality monitoring requirements.

  Six PFAS and seven hormones were sampled between 2013 and 2015 as part of the federal UCMR3 data request. All of these results were non-detect.

  Additionally S-29 (the Betti well) was sampled for residual chemicals twice. The first time as part of the groundwater characterization effort in 2015, where samples were analyzed for residual chemical but not for PFAS. Detections in 2015 were seen for three chemicals; acesulfame K (1600 ng/L), sucralose (600 ng/L), and TCPP (100 ng/L, the detection limit). S-29 was sampled again in 2020 and detections were seen for four residual chemicals acesulfame K (430 ng/L), sucralose (1100 ng/L), primidone (9.9 ng/L) and sulfamethoxazole (7.7 ng/L) and four PFAS. (see attached).

Human Health Risk Assessment

- The overall approach of the Human Health Risk Assessment (HHRA) is well designed, estimates potential risks for receptor groups most likely to be exposed, and is conservative. That is, estimates of risk presented in the HHRA are far more likely to overestimate than underestimate potential risk. The Panel recommends clear communication of this aspect of the analysis.

  LOTT: Noted.

- The preliminary draft of the HHRA identifies nine chemicals of interest (COI) with potential risks exceeding the allowable risk thresholds identified in the HHRA. Several of the exceedances are for COI that were not detected in monitoring wells. The characterization of potential risks associated with COI not detected in monitoring wells should be evaluated further. While it is common practice in an HHRA to use one-half of the method detection limit (MDL) for compounds that are not detected in a sample, it is also generally the case that, when a compound is not detected in any samples, it is not included in the quantitative characterization of potential risk. When such non-detected compounds are included in the risk characterization, an unacceptable risk can be estimated, as is the case with several COI for several receptors and exposure media in this instance. That can be a misleading result given that the compound may not be present. Clearly, substantial uncertainty exists about the true concentration of such a compound and, thus, also any potential risk it may pose. It may be better to discuss the potential risks associated with such COI in the uncertainty section of the HHRA and exclude them from the quantitative risk characterization.

LOTT: The HHRA has been revised to quantitatively evaluate only those COIs that were detected in monitoring wells. Non-detected compounds with MDLs that exceed DWELs will be discussed in the uncertainty section.

- In addition to the above comment about the HHRA estimating potential risks based on one-half of the detection limit, it would be better if the HHRA and Ecological Risk Assessment (ERA) treated non-detect COI similarly. Currently, the HHRA estimates potential risks assuming one-half of the detection limit while the ERA excludes non-detected compounds. While the Panel believes it is more appropriate to exclude such non-detect COI from the quantitative risk characterization, the approach in the HHRA and ERA should be consistent or, if the approaches remain distinct, the reason for the distinction should be discussed.

  LOTT: With the modified approach noted above, the HHRA and ERA treatments of non-detected COIs are now consistent.

- Potential risks associated with fish consumption exceed allowable risk thresholds identified in the HHRA for eight COI. The estimates of potential risk are likely to be overly conservative for at least three reasons:
  - As discussed above, assuming non-detect COI are present at one-half the detection limit is an uncertain and likely conservative assumption and is used to estimate potential risks associated with fish consumption for five of the eight COI.
  - The current estimates of potential risk do not account for dilution of reclaimed water in the receiving surface waters. As discussed on the call, the Panel supports the intention of the HHRA (and ERA) teams to incorporate such dilution using mass flux estimates to refine estimates of potential risk.
  - The fish consumption rate used by the HHRA to estimate potential risks likely cannot be supported by the portions of the creeks into which reclaimed water is predicted to discharge. Consideration of sustainability of fish production often places limits on fish consumption rates that should be used in HHRAs, particularly for smaller bodies of water such as the creeks evaluated in this HHRA. The HHRA

team may wish to review a recent publication on this topic[1] and refine the fish consumption rates used in the preliminary HHRA.

LOTT: See the above notes regarding the modified approach applied to COIs not detected in monitoring wells. Estimated EPCs for COIs in the creeks now incorporate dilution. In addition, fish consumption rates are being examined more closely and will be refined to reflect more realistic assumptions about consumption including consideration of creek productivity.

- Several COI have potential risks that only slightly exceed allowable risk thresholds identified in the HHRA. Their potential risks are also within the Environmental Protection Agency (EPA) allowable risk range and are well below risk levels considered acceptable by the EPA when setting drinking water criteria. Given the conservative nature of many of the exposure and toxicity assumptions, the Panel encourages the HHRA team to explore presenting the comparison of estimated potential risks to a range of risk thresholds considered allowable by the EPA and other regulatory agencies. As discussed during Panel Meeting 4, presenting information on other sources of exposure and potential risk also provides important perspective when evaluating potential risk associated with exposure to COI in reclaimed water.

  LOTT: In the results discussion, quantitative cancer risk estimates will be compared to a range of acceptable risk values (10^{-4} to 10^{-6}).

- The HHRA currently evaluates each PFAS as an individual COI. Given that these COI may have a common mechanism of action, the HHRA team may wish to consider discussing the potential risk associated with these compounds as a class.

  LOTT: Risks will be presented for individual PFA compounds as there is some variation in mechanisms of action as well as the nature and quality of available toxicity data for the compounds (e.g., some compounds have undergone much more extensive toxicological investigation). Potential risks for the compounds as a class will be discussed in the uncertainty section.

- Given the potential for PFAS to drive unacceptable exposure risks at this location and many others, and the considerable uncertainty which exists with respect to PFAS chemical compositions, the Panel recommends considering total organic fluorine and/or oxidizable precursor analyses and data collection, and comparison with current PFAS data if PFAS risks begin to dominate the human health screening evaluation.

  LOTT: LOTT will take this into consideration as a potential future additional step.

[1] Pfeiffer and Anderson. 2021. *Estimated Sustainable Fish Production: Effect on Fish Consumption Rates Used to Develop Remediation Goals at Contaminated Sediment Sites.* IEAM, 17(3):584–596.

- The estimates of potential risk, both human and ecological, are based on model runs that predict concentrations that will be present in some locations more than 100 years from now. Risk assessments typically focus on exposures that are occurring now or may occur in the reasonably foreseeable future. The Panel suggests that the risk assessments should point out that some of the risks that are being presented do not occur now and will not exist for decades, even if the reclaimed water program moves forward exactly as modeled. Therefore, readers of the risk assessment data should be aware that the time frame for the various risks is not the same.

  LOTT: Noted. The time element of this analysis will be emphasized in the risk assessment documentation.

Ecological Risk Assessment

- The overall approach of the ERA is well designed, estimates potential risks for receptor groups most likely to be exposed, and like the HHRA, is conservative.

  LOTT: Noted.

- The Panel has no comments applicable to just the ERA. As discussed during Panel Meeting 4 and above for the HHRA, the Panel supports the intention of the ERA team to incorporate dilution of reclaimed water in receiving surface waters to refine estimates of potential risk associated with fipronil and other COI that may have potentially unacceptable risks.

  LOTT: Noted.

- Fipronil is generally considered to be a relatively hydrophobic sorbate, with a moderately high logK_{ow} and stronger binding to soil/media, so please check and consider its potential for long-range groundwater transport carefully. This recommendation also applies to the comment about clarification of the classifications of Category 2 compounds in the Hydrogeologic Study/Fate and Transport Analysis section of this memo.

  LOTT: The fate and transport analysis is taking a closer look at fipronil and will be discussing the likelihood for greater attenuation than previously expressed. This will then be reflected in the risk assessment.

Conclusion

The purpose of the NWRI Panel is to provide an independent, third-party expert peer review of the technical, scientific, regulatory, and policy aspects of your project. A draft report was provided as a courtesy to allow an opportunity for the project partners to identify any faulty premises, incorrect assumptions, and other similar mistakes of fact, or to request clarification regarding any of the findings and recommendations.

This final version of the report includes the LOTT project team's responses to the Panel's recommendations.

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, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

For more information, please contact:

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

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 WateReuse Association's 2005 Person of the Year. In 2016 he received the California WateReuse Presidential Award. Crook received both an MS and PhD in Environmental Engineering from University of Cincinnati, and a BS in Civil Engineering from University of Massachusetts.

Paul Anderson, PhD, is Vice President and Principal Scientist at ARCADIS US, Inc, in Chelmsford, Massachusetts. He has more than 35 years of experience in human health and ecological risk assessment. His research includes investigating the potential presence and effects of active pharmaceutical ingredients and personal care products in surface water. His research in constituents of emerging concern began with the development of a screening level model that predicts the concentration of human pharmaceuticals and other compounds released from wastewater treatment plants (WWTPs) in surface water across the United States. 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 Principal Hydrogeologist with GeoEngineers in Redmond, Washington. 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 4

June 21, 2021

Location	Contacts
GoToMeeting	Kevin Hardy: 760.801.9111
See Outlook invite for login information	Suzanne Sharkey: 949.258.2093

Meeting Objectives

- Brief the Panel and receive feedback on draft documents for Task 2 (Treatment Effectiveness) and Task 3 (Risk Assessment)
- Facilitate interaction between the Panel and the LOTT project team
- Allow working time for the Panel to discuss initial feedback

OPEN STAKEHOLDER WORKSHOP: 10:00 a.m. to 12:30 p.m.

10:00 a.m.	Welcome, introductions, and review meeting objectives and agenda	Kevin Hardy, NWRI, and Jim Crook, Panel Chair
10:10 a.m.	Reorientation to project and timeline	Wendy Steffensen, LOTT
10:15 a.m.	Brief on Hydrogeologic Model: Fate and Transport Analysis	Jeff Hansen and Shane McDonald, HDR
10:45 a.m.	Brief on Human Health Risk Assessment	Gretchen Bruce, Intertox
11:15 a.m.	Brief on Ecological Risk Assessment	Kate McPeek, Windward
11:45 a.m.	Panel Q & A	Facilitated by Jim Crook
12:30 p.m.	Wrap up with Science Task Force	

CLOSED PANEL WORKING SESSION: 12:30 noon to 2:00 p.m.

12:30 p.m.	Closed Panel session	Facilitated by Jim Crook
2:00 p.m.	Adjourn	

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, PHG, 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 Duerte, HDR
- Gretchen Bruce, Intertox
- Kate McPeek, Windward Environmental

Science Task Force

- Donna Buxton, City of Olympia
- Erin Conine, City of Olympia
- Carrie Gillum, City of Tumwater
- Kevin Hansen, Thurston County
- Erica Marbet, Squaxin Island Tribe
- Koenraad Mariën, Washington State Department of Health
- Hans Qiu, Washington State Department of Ecology
- Julie Rector, City of Lacey
- Dan Smith, City of Tumwater
- Art Starry, Thurston County

National Water Research Institute

- Kevin M. Hardy
- Mary Collins
- Suzanne Sharkey