

**Utah Lake Water Quality Study
Science Panel Meeting #6
Summary
December 10-11, 2019**

This document includes a list of future meetings, action items, and a brief summary of the discussions. Please review the action item list for tasks assigned to you and/or the Steering Committee in general. A list of attendees can be found at the end of the document.

Upcoming Meeting/Call	When	Suggested Agenda Items
ULWQS Science Panel (Call #10)	January 20-24, 2020	○ Discuss TSSD proposal and relationship to charge
ULWQS Science Panel (Call #11)	March 2-6, 2020	○ Seek final approval of Uncertainty Guidance, Framework, and Strategic Research Plan (and confirm priority RFPs)
ULWQS Science Panel (Meeting #7)	March 16-27, 2020	○ Develop/finalize RFPs from Strategic Research Plan

I. Action Items

Meeting Summaries	Who	Due Date	Completed
1. Post background materials and presentations to Dropbox [link]	Facilitation Team	Thurs, Dec. 12	Thurs, Dec. 12
2. Share draft meeting summary	Facilitation Team	Tues, Dec. 24	Tues, Dec. 24
3. Review and share comments on summary	Science Panel	Tues, Jan. 7	None received
4. Finalize meeting summary/post to Dropbox	Facilitation Team	Wed, Jan. 8	Wed, Jan. 8
Near-term Research Projects	Who	Due Date	Completed
5. Respond to question about sources of elevated ¹⁵ N concentrations in sediment samples	Janice Brahney		Tues, Dec. 10
6. Provide Hidding paper on macrophytes to be added to Dropbox	Soren Brothers		Tues, Dec. 10
7. Share draft research study report	Goel/Carling Team	Tues, Jan. 21	
8. Compute nutrient exchange rates per	Goel/Carling Team	Tues, Jan. 21	

meter squared			
9. Update statistics in data analysis per Science Panel request/suggestion	Aanderud Team	Fri, Jan. 31	
10. Provide updates to Science Panel as progress is made	Brahney Team	TBD	
University of Utah Model Development	Who	Due Date	Completed
11. Provide estimate of the proportion of the water inputs to Utah Lake that come from groundwater	Nick Von Stackelberg	Fri, Jan. 31	
12. Review the mechanistic model and develop list of gaps and necessary additions for use in the ULWQS	Tetra Tech/Science Panel/U of U	Fri, Feb. 28	
13. Develop recommended mechanistic model uncertainty approach	DWQ/Tetra Tech/U of U/ James Martin	Fri, Feb. 28	
Science Panel Technical Support/Data Characterization	Who	Due Date	Completed
14. Share paper on DO and toxins to be added to Dropbox	Hans Paerl		Wed, Dec. 11
15. Review Uncertainty Guidance and Framework documents and provide comments/edits before it is finalized	Science Panel	Fri, Jan. 10	
16. Share draft Strategic Research Plan document	Tetra Tech	Fri, Feb. 14	
17. Review DWQ sonde data and evaluate whether there is bias due to pH values	Tetra Tech/DWQ	Fri, Jul. 3	
18. Perform seasonal analysis of chlorophyll a and turbidity data	Tetra Tech/DWQ	Fri, Jul. 3	
19. Provide a time-series analysis of zooplankton data	Tetra Tech/DWQ	Fri, Jul. 3	
TSSD Study	Who	Due Date	Completed
20. Share TSSD study overview and initial charge with SP for review	Facilitation Team	Thurs, Dec. 12	Thurs, Dec. 12

21. Confirm need for and then schedule SP call to discuss study design with TSSD	Facilitation Team	Fri, Jan. 10	
22. Review TSSD study and initial charge and share thoughts on design and overlap	Science Panel	Fri, Jan. 10	
Miscellaneous	Who	Due Date	Completed
23. Initiate scheduling for 2020 calls and meetings	Facilitation Team/ DWQ/Tetra Tech	Fri, Jan. 10	Mon., Jan 6
24. Share macrophyte study report	Tetra Tech/DWQ	Fri, Jan. 10	
25. Share fisheries study report when publicly available	Mike Mills/JSRIP	Fri, Jan. 31	
26. More explicitly present opportunities for public engagement in future meeting agendas	Facilitation Team	TBD	

Tuesday, December 10, 2019 9:00 a.m. to 5:00 p.m.

II. Meeting Recording – December 10

Recordings of the meeting (also available on the DWQ website in the near future) can be found at the following links:

- December 10 (AM): <http://resolv.adobeconnect.com/pcuq0t8cz0jx/>
- December 10 (PM): <http://resolv.adobeconnect.com/pb4c00hboj4t/>
- December 11 (all day): <http://resolv.adobeconnect.com/pr0yh9ynoear/>

Please use the video scroll bar along the bottom of the recording window to find the appropriate time in the webinar recording for the session you would like to watch. There are bookmarks in the 'Events Index' on the left side of the screen identifying each session.

III. Key Points of Discussion – December 10

Welcome and Agenda Review

Paul De Morgan, RESOLVE, welcomed everyone to the meeting and asked the group (members of the Science Panel and members of the public) to introduce themselves (see Section VII. Participation – December 10 and 11 below). He went over the list of meeting materials, agenda items, and meeting ground rules.

Mr. De Morgan explained that the Steering Committee had voted to fill the vacancy on the Science Panel with Mike Mills of the Central Utah Water Conservancy District/June Sucker Implementation Recovery

Program during their meeting on December 2, 2019. He added that while Mike would not be attending in person due to a prior commitment he would join for most of the meeting by phone/Adobe Connect.

Near-term Research Plan Update

Utah Lake-sediment water nutrient interactions – Members of the research team (Sheena Smithson and Hanyan Li) provided a summary of the work completed to date and presented the preliminary data results of the study. They explained that one of the main preliminary findings of the study is that the greatest release of nutrients from the sediments was at the lowest water column concentrations and the greatest sink into the sediments was observed under the highest water column concentrations. The greatest phosphorus release occurred during aerobic conditions and not during anaerobic conditions, likely due to calcite binding of phosphorus. The research team struggled to control pH in the experiment and may have accidentally created anaerobic conditions in some treatments.

Bioassays to investigate nutrient limitation of Utah Lake – Dr. Zach Aanderud, BYU, provided an update on the study and the initial results compiled to date. He explained that to date three separate bioassay experiments have been completed. The majority of the experimental treatments were found to be co-limited by nitrogen and phosphorus. Dr. Aanderud explained that the research team plans to measure rates of atmospheric nitrogen fixation. He also explained that the team plans on doing additional experiments and will provide updates to the Science Panel as more results are generated.

Paleolimnology and paleoecology of Utah Lake – Dr. Janice Brahney, USU, explained that the research team has been analyzing both cores that were collected 2 years ago and cores that were collected this past summer. She explained that ^{210}Pb dating did not prove to be possible but ^{137}Cs seems to have worked well, as cesium is found in the sediment record due to historical bomb testing in the greater region. She explained that the team applied a regime shift index to the data and identified 1923 and 1941 as periods of dramatic changes in the lake. These dates help to categorize the history of the lake into three distinct periods: Pre-regime shift (1640-1869): benthic macrophytes, high c:n ratios, and low ^{15}N enrichment of the lake, Post-regime shift (1869-1945): increasing pelagic algal pigments and decreased sediment stability, and Continued eutrophication (1945- present): high pelagic chl a concentrations, isotopically-enriched ^{15}N , and decreased diatom pigments.

There was some discussion with the Science Panel about the cause of elevated ^{15}N ratios and the importance of nitrogen fixation compared to inputs of nitrogen from POTWs. Dr. Brahney explained that there have been some delays to the project due to sample analysis by contracted laboratories, but they research team will hope to be able to share a report draft in early 2020. She stated that updates will be provided to the Science Panel as they become available.

Operationalizing the ULWQS Uncertainty Guidance

Mike Paul, Tetra Tech, described the types of uncertainty (quantitative and qualitative) and the framework that has been developed for this study, which is based on the IPCC uncertainty framework. He described the challenges associated with expressing uncertainty and how uncertainty can be described, and suggested some example statements of how the Science Panel could consider expressing uncertainty related to the findings of studies. He explained that expressions of uncertainty should include a likelihood statement, confidence, and traceable accounts.

James Martin presented different methodologies for characterizing uncertainty in mechanistic modeling with the goal of identifying an approach for recommendation to the University of Utah modeling team. He discussed several options for evaluating input parameter uncertainty including data corroboration or calibration, expert opinion, multiple models, and sensitivity analysis. He stated that it is ideal to take a standard calibration step; however, this is only possible when data is available for calibration of modeled data. Dr. Martin described types of sensitivity analysis that are commonly used in mechanistic modeling such as Monte Carlo simulations, Bayesian Monte Carlo, Markov Chain Monte Carlo, and Bayesian model averaging. Dr. Martin posed the question of whether the Science Panel feels that current limitations to the Utah Lake model are more related to model framework or input-related uncertainty or limitations. One member of the Science Panel observed that gaps in the model framework appear to be the most critical limitations at this point. A suggestion was made for the Science Panel to develop a comprehensive list of framework gaps and limitations of the model so that they can begin to develop potential solutions.

Numerical Nutrient Criteria Technical Framework

Mike Paul presented on questions surrounding the development of nutrient targets needed to help protect beneficial uses for Utah Lake. He explained that he, along with Scott Daly, UDWQ, had conversations on this subject during one-on-one phone calls with each of the Science Panel members. Dr. Paul summarized the common themes related to numeric nutrient criteria endpoints that could be established to protect the various beneficial uses of Utah Lake. He explained that in order to derive nutrient criteria, endpoints need to be clearly linked to specific nutrient effects. One member of the Science Panel suggested that chlorophyll a be used as an endpoint and there was significant discussion among the Science Panel related to different indicators that are linked to chlorophyll a. The suggestion was made that chlorophyll a could perhaps be linked to dissolved oxygen, or maybe pH; however, the clarification was made that dissolved oxygen concentrations are not known to be a problem in Utah Lake. There was significant discussion related to potential correlations between different in-lake parameters and the feasibility of using specific parameters as criteria. A suggestion was made to develop a range of potential endpoints or a couple of options for specific numeric criteria necessary to achieve certain endpoints that could be presented to the Steering Committee.

The Science Panel divided into two groups and went through an exercise where they utilized mock data to identify numeric criteria for three different endpoints. Once each group had identified the numeric criteria, they developed statements to characterize the uncertainty associated with each number, per the previous discussion on uncertainty. The exercise provided an opportunity to simulate how the Science Panel might consider multiple lines of evidence, develop a recommendation in light of uncertainties, and allow them to consider what the potential challenges might be for identifying these criteria for Utah Lake.

Utah Lake Model Development Update

Nick Von Stackelberg, UDWQ, went over the framework for the Utah Lake model being developed by the University of Utah team. He described the various components of the model including the WASP, EFDC, and SWIM sub-models and explained that the watershed model does not include the upper watershed to Utah Lake and may not be appropriate for use in the ULWQS. Members of the Science Panel indicated that they feel that the watershed inputs can be modeled by other means, such as mass-balance of flow and nutrient data for the inflow streams, and therefore feel that this is not a major concern. The group agreed the critical next steps include identifying the gaps and necessary changes to

the model that the University of Utah team is developing, developing a plan for addressing these gaps, hiring a consultant to run the model for the Science Panel, and considering whether the development of a watershed model in the future will be necessary. Scott Daly suggested that it is important to start working on a scope of work for a consultant to help run the model.

IV. Public Comment – December 10

Rich Mickelson, Timpanogos Special Service District: Nick (Von Stackelberg), do you have more information on groundwater? A report I read said that more than 50% of the water going to Utah Lake is from groundwater.

Nick Von Stackelberg, UDWQ: Our model does not include a direct measure of ground water, but I have also heard that it is a large portion. I will look into this and will follow-up with Rich.

Day 2: Wednesday, December 11, 9:00 a.m. to 5:00 p.m.

V. Key Points of Discussion – December 11

Welcome and Agenda Review

Dave Epstein, SWCA, welcomed the group to the second day of the meeting and reviewed the meeting agenda.

Strategic Research Plan Development

Mike Paul, Tetra Tech, went over the charge questions from the Steering Committee to the Science Panel and the sub-questions that were developed by the Science Panel to help answer the charge questions. For each sub-question Dr. Paul outlined what monitoring, research, and/or analysis has been done or is underway in attempt to answer each of the sub-questions. He identified the questions that have yet to be answered and for which no research is currently underway.

Extensive discussion ensued among the Science Panel related to the charge and sub-questions. The discussion centered around whether nutrient targets can be met by reductions in nutrient inputs or whether internal nutrient cycling is dominant, whether turbidity in the lake can be controlled by limiting phytoplankton growth or if turbidity is largely non-algal, what would happen to the lake if nothing is done to control nutrients, and more. The Science Panel considered the information that the bioassay study and the nutrient mass-balance will be able to provide and what information additional research studies might be able to provide to answer the critical questions. Dr. Paul explained that the aim of the Strategic Research Plan is to identify research areas of the highest priority in the near-term so that plans can be developed to address those priorities.

The Science Panel was then divided into two groups and each group went through two iterations of an exercise to rank a list of research areas developed previously by the Science Panel. First, each Science Panel member went through the list of research areas by themselves, adding additional topics if they felt any were missing from the list, and then ranking the various research areas from highest to lowest priority. Next, each small group, came together to discuss the individual rankings before coming to a consensus on a shared list and ranking for presentation to the whole Science Panel. The rankings from each of the two groups were compared and appeared to be quite similar, with both sub-groups ranking

the same group of research areas as the highest priority. Dr. Paul explained that following the meeting he would review the rankings and share a draft Strategic Research Plan for review by the Science Panel. A number of participants stressed the importance of completing the Strategic Research Plan as soon as possible so research projects can be planned for the upcoming field season.

Recap Connections/Interactions/Gaps between Framework, Uncertainty, and Strategic Research Plan

Dr. Paul provided a brief overview of the Panel's discussions during the meeting thus far and then shared his perspectives on the progress toward integrating the various components of the Tetra Tech work plan. Members of the Science Panel made comments related to in-lake targets, what may be controlling toxin inputs to the lake, what the various near-term research projects may provide in terms of increased knowledge of the ecosystem, and more. One member of the Science Panel (Ryan King) commented that there is a lot of important data that is lacking, and a mesocosm-type experiment could be very helpful in providing clues related to the missing information.

Data Characterization Analysis Plan Results and Discussion

Dr. Paul presented an update on the effort to characterize the available data from DWQ monitoring of Utah Lake. The various areas of data characterization explored by Tetra Tech are: 1) carp excretion; 2) algal cell count and pigment relationships; 3) sonde data analysis; 4) plankton temporal and spatial analysis; 5) diatom and macrophyte autecology; 6) wind and turbidity; 7) turbidity and macrophytes; and 8) light extinction. Dr. Paul announced that there is an updated version of the Shiny app that allows members of the Science Panel to review and analyze the DWQ data set from their Utah Lake monitoring efforts. He presented numerous analyses of sonde data and highlighted how the Provo Bay sonde data really sticks out from the rest of the data. Questions were raised about the sonde data and the potential influence or bias from pH, and Dr. Paul committed to furthering the analysis of sonde data. Dr. Paul also mentioned that reports have recently been completed from both macrophyte and fisheries studies in Utah Lake, which will be shared with the Science Panel in due time. The fisheries study report is not for public review and therefore will be shared confidentially with the Science Panel. He also stated that an updated analysis report will be completed by the Tetra Tech team in the late spring for Science Panel review.

Update and Discussion on Conceptual Models

Dr. Paul briefly presented the conceptual models of Utah Lake and stated that he expects them to be finalized following the meeting. One suggestion from the Science Panel was made to ensure there is a clear pathway depicted in the simplified model for regeneration of nutrients from the sediments back into the water column. Dr. Paul committed to making the change before finalizing the models barring no further comments or suggested edits from the Science Panel.

Atmospheric Deposition of Nutrients to Utah Lake

Paul De Morgan provided an overview of the recent efforts related to estimation of atmospheric deposition of nutrients to Utah Lake. He explained that Mike Brett, building on the Panel's discussions at their July meeting, had drafted a recommendation regarding incorporation of deposition estimates from the Brahney white paper for use in the University of Utah model. Dr. Brett explained that the University of Utah modeling team is completing their model now and therefore needs estimates of atmospheric deposition to incorporate into the model, and that the numbers from the white paper seem to be the

best starting point. Mr. De Morgan asked the Science Panel whether in light of the uncertainty guidance conversation that took place the day before, they might like to add any language to the memo to express uncertainty associated with the deposition estimates. Dr. Brett indicated he felt information about uncertainty already included at the beginning of the document is sufficient.

Theron Miller expressed his disagreement with using the estimates from the white paper in the model because it is regional data and does not incorporate the data from estimates that have been made locally (i.e., Olsen thesis). Dr. Miller offered to share a little information from the independent review of the atmospheric deposition issues with the group for context. Mr. De Morgan noted that the process agreed to previously was for both of the independent reviews to be made available to the entire Science Panel simultaneously and, since they were not both available yet, neither had been shared. He added that the chair (Mitch Hogsett) had been provided a copy of the first independent review prior to the meeting in his liaison role between the Panel and the WFWQC. At that point, Dr. Hogsett provided an update on the independent reviews of the estimates and documents related to the estimation of atmospheric deposition of nutrients to Utah Lake. He confirmed that two independent reviewers had been contracted and while one of the reviews had already been received, they were still waiting to receive the second review.

Additional discussion ensued related to the potential incorporation of the local estimates of deposition into the estimates to be used in the model. Dr. Miller explained that the uncontaminated estimates from the Olsen thesis are only 16% higher than the numbers presented in the white paper. Dr. Brett expressed his openness to incorporating this uncontaminated estimate, but stated that because the recommendation in the white paper is an average, inclusion of this estimate would not dramatically affect the final value. Mr. De Morgan asked for the independent members of the Science Panel to vote on whether to use the estimates in the Brahney white paper in the model and all independent members supported their use in the model. He also reminded the group that other Panel members are welcome to provide additional thoughts regarding recommendations in writing.

Mr. De Morgan then opened the discussion to members of the public. David Richards, OreoHelix Ecological, expressed his concern that using data from Lake Tahoe as a surrogate for Utah Lake is not appropriate. Members of the Science Panel responded that Lake Tahoe was only used in the white paper to provide a theoretical extinction coefficient for how far particles might travel across the lake. They clarified that deposition rates for nutrients from Lake Tahoe were not utilized in the estimates included in the white paper. Dan Potts, Salt Lake Fish and Game Foundation, suggested that sonde data needs to be analyzed on a daily basis because conditions in the lake can change very quickly. Additionally, he explained that when dry portions of the lake are inundated there is likely a large influx of nutrients to the lake from those sediments.

Utah Lake Research Presentations – Part 1

Factors effecting the ecological health and integrity of Utah Lake with a focus on the relationships between water column regulators, benthic ecosystem engineers, and cyanoHABs. David Richards, OreoHelix Ecological. Dr. Richards went through his report and explained some of the key findings and suggestions to the Science Panel. He stressed the importance of midges to the lake ecosystem and the historical importance of mussels and snails, which are no longer abundant in the lake.

Utah Lake Mass Balance Analysis Update

Scott Daly gave an update on the effort to compile flow and nutrient data for all of the tributaries to Utah Lake. He described both the efforts to compile existing data sets and efforts to collect new data from sites proximal to Utah Lake and sites in the upper watersheds of the tributary streams. Mr. Daly explained that there are three tiers to the methodology for developing the mass balance and described each of the tiers.

Utah Lake Research Presentations – Part II

Introduction to Timpanogos Special Service District In-lake Nutrient Cycling Studies – Jeff DenBleyker, Jacobs. Mr. DenBleyker presented the background and details of a study that Jacobs has been hired to design for the Timpanogos Special Service District (TSSD). He explained that the TSSD is exploring concepts for nutrient reductions of effluent and for nutrient sequestration within Utah Lake. He described a mesocosm experiment in Utah Lake that would explore the exclusion of carp from and the geochemical augmentation of the lake. Mr. DenBleyker stated that Jacobs would be involved in the study design and a pilot study, but TSSD envisions a larger study to be completed by a university and graduate students. He expressed the vision to engage the Science Panel and to receive their input on the study design so the results of the study would be of value to the ULWQS.

Members of the Science Panel asked questions about the details of the study such as the economical and logistical feasibility of treating Utah Lake with alum and removing carp entirely from the lake if the study suggests that these methods would be effective. Additionally, the suggestion that nutrient sequestration within the lake cannot be compared equally to effluent treatment as effluent treatment can remove other pollutants such as nitrogen, pharmaceuticals, and others, while the alum treatment would only sequester phosphorus.

At the conclusion of the session, the Panel agreed to review the description of the project and share additional thoughts as appropriate on the design in January. They also indicated they would review their charge questions in light of the proposed study to look for synergies between what was being proposed and the questions they need to address. Additional follow up is anticipated in January.

VI. Public Comment – December 11

Dan Potts, Salt Lake Fish and Game Foundation: Phragmites – more valuable than native hardstem bulrush in: 1) providing far better structural complexity for young fishes of all kinds. 2) providing de-silting capacity of shoreline areas.

Water budget – needs to include the huge influences of the significant (~60,000 AF) diversion from the south slope of the Uinta Mountains through the Strawberry Reservoir to the Spanish Fork River, Hobble Creek, and the Provo River. Oriental weatherfish – not a concern of mine. Personally reared them in aquaria; didn't evolve in a lake like Utah Lake. Although common in the Jordan River and virtually all irrigation and drainage ditches in Salt Lake County, I don't feel they pose any reasonable threat to Utah Lake's ecology because: 1) they are very small – only 3-6" long; and 2) not highly fecund; and 3) most importantly – are simply not preadapted to such and unusual and challenging ecosystem like Utah Lake.

VII. Participation – December 10 and 11**Meeting Participants (Name, Organization) – December 10****Members of the Science Panel:**

- Janice Brahney, Utah State University (Adobe Connect)
- Mike Brett, University of Washington
- Soren Brothers, Utah State University
- Greg Carling, Brigham Young University (Adobe Connect)
- Mitch Hogsett, Forsgren Associates, Science Panel Chair
- Ryan King, Baylor University
- James Martin, Mississippi State University
- Theron Miller, Wasatch Front Water Quality Council
- Mike Mills, June Sucker Recovery Implementation Program
- Hans Paerl, University of North Carolina

Technical Consultant Staff:

- Michael Paul, Tetra Tech

Members of the Public:

- Zach Aanderud, Brigham Young University
- Jeff DenBleyker, Jacobs
- Ramesh Goel, University of Utah
- Heidi Hoven, National Audubon Society
- Erin Jones, Brigham Young University
- Chris Keleher, Utah Department of Natural Resources – Steering Committee
- Hanyan Li, University of Utah
- Renn Lambert, LimnoTech (Adobe Connect)
- Dan Potts, Salt Lake Fish and Game Foundation
- David Richards, OreoHelix Ecological
- Sheena Smithson, Brigham Young University
- Ella Sorenson, National Audubon Society

Utah Division of Water Quality Staff Present:

- Scott Daly, Utah Lake Project Coordinator
- Erica Gaddis, Co-Chair, Utah Lake Water Quality Study
- Jodi Gardberg, Watershed Protection Section Manager
- Nick Von Stackelberg, Modeler

Facilitation Team:

- Paul De Morgan, RESOLVE
- Dave Epstein, SWCA

Meeting Participants (Name, Organization) – December 11**Members of the Science Panel:**

- Mike Brett, University of Washington
- Soren Brothers, Utah State University
- Mitch Hogsett, Forsgren Associates, Science Panel Chair
- Ryan King, Baylor University
- James Martin, Mississippi State University
- Theron Miller, Wasatch Front Water Quality Council
- Mike Mills, June Sucker Recovery Implementation Program
- Hans Paerl, University of North Carolina

Technical Consultant Staff:

- Michael Paul, Tetra Tech

Members of the Public:

- Jeff DenBleyker, Jacobs
- Renn Lambert, Limnotech (Adobe Connect)
- Dan Potts, Salt Lake Fish and Game Foundation
- David Richards, Oreo Helix
- Brian Selck, Timpanogo SSP

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