Scope of Work: Historic Trophic State and Nutrient Concentrations in the Paleo Record of Utah Lake

1 Introduction

The Utah Department of Environmental Quality, Division of Water Quality (DWQ) is requesting grant proposals for technical support to conduct a paleolimnological study of Utah Lake. A Paleo experimentation was prioritized for 2019 by the Utah Lake Water Quality Study (ULWQS) Science Panel to determine the historical nutrient regime of the lake. The target completion date of this scope is January 31, 2020.

Please submit a grant proposal including a cost proposal to Emily Canton at ercanton@utah.gov by 5:00 PM MST May 22, 2019. Proposals must be limited to 10 pages; this page limit does not include resumes and project case studies that may be included in an appendix.

2 Background

The Utah Division of Water Quality (DWQ) recently initiated Phase 2 of the Utah Lake Water Quality Study (ULWQS) to evaluate the effect of excess nutrients on the lake's recreational, aquatic life, and agricultural designated uses and to develop site-specific nitrogen and phosphorus water quality criteria to protect these uses. The ULWQS is guided by the Stakeholder Process (Attachment A) developed during Phase 1, which established a 16-member interest-based Steering Committee and a 10-member disciplinary-based Science Panel. The Steering Committee has charged the Science Panel with developing and answering key questions to characterize historic, current, and future nutrient conditions in Utah Lake (Attachment B). Responses to the key questions will be used by the Steering Committee to establish management goals for the lake and by the Science Panel to guide development of nutrient criteria to support those goals.

Additionally, the Science Panel must complete a significant number of tasks to achieve its purpose of guiding the development of nutrient criteria as described in Attachment C including:

- Guiding the approach for establishing nutrient criteria
- Recommending and guiding studies to fill data gaps needed to answer key questions
- Interpreting and integrating study results into the rationale for nutrient criteria

- Guiding development of an approach for characterizing uncertainty
- Recommending science-based nutrient criteria to the Steering Committee

Problem Statement

Information on historic, even pre-settlement chemical and biological conditions in Utah Lake are underdeveloped but are important in developing nutrient thresholds for protection or restoration of the lake. Pre-settlement conditions are described for macrophyte resources in Utah Lake based on descriptions in pre-1974 literature, but a longer-term paleo record of macrophytes is not available. Paleoecological interpretation of diatom assemblages in the lake suggests that the lake has changed from a deep mesotrophic state to a shallow eutrophic state over time. Despite this and other research using paleolimnological coring to infer past conditions, consistent application of advanced core age-dating approaches and paleo-analytical techniques to spatially representative and comprehensive cores across this ecosystem has been limited. As a result, current estimates of the timing of changes observed in cores, associated sedimentation rates, and inference of past chemical and biological conditions remain somewhat speculative, and it is believed that research using consistently applied, advanced techniques would improve certainty. Knowing the pre-settlement chemical (phosphorus, nitrogen, silicon, calcium, iron, and potentially N and P isotopes) concentrations and how they have changed will help inform development of numeric nutrient targets. A long-term record of diatom and macrophyte assemblages in the paleo record of Utah Lake could provide information on the historical trophic state and nutrient regime of the lake, also important in understanding appropriate targets for protection or restoration.

DWQ recognizes that there may be difficulties in dating/quantifying changes in shallow, well-mixed lake ecosystems due to mixing of the surface sediments. Any details on the extent of this as an issue for characterizing past conditions in Utah Lake as well as recommendations on how that uncertainty will be overcome or quantified in the proposal are welcome.

Existing Data and Information (see also Attachment C)

Over the past several decades, a variety of paleolimnological and historical studies have attempted to recreate past conditions in the Utah Lake ecosystem using a variety of approaches. Early piston cores and analysis of algal and mollusk remains suggested a shift from oligo/mesotrophic conditions to eutrophic/alkaline conditions along the gradient of the core (Bolland 1974). A shift in diatom assemblage structure was noted in a later study of three cores from the lake (Javakul et al. 1980), but there was not as much effort to link these changes to paleoenvironmental reconstruction; however, they were linked to pre and post-settlement conditions using dandelion pollen. Finally, Macharia (2012) used lake cores to reconstruct historic and prehistoric environments through geochemical proxies and concluded that disturbance at the time of establishment of agriculture and urban settlement around Utah Lake altered nutrient and particulate matter fluxes into the lake.

Bushman (1980) calculated a net sedimentation rate from 1849 to 1972 of 1.38 cm per year based on the presence of dandelion pollen in sediment cores. He concluded that the rate of sediment deposition has

increased since settlement of the Utah Valley; however, there was disagreement among researchers (e.g., Bolland 1974; Javakul et al. 1980) on sedimentation rates calculated from different cores using different dating methods and on interpretation of paleoecological conditions in the lakes based on various core proxies.

Aside from paleo-reconstruction using lake bed cores, Brotherson (1981) provided a thorough description of aquatic and semiaquatic plant communities around Utah Lake and its major bays. The study offered detailed descriptions taken from literature (pre-1974) and supplemented with 1976 field surveys. Plant community types identified and quantified across the lake included density characteristics representing the publication period (late 1970s). The early settlement period was also characterized. Although specific measures of plant community effects on water quality (e.g., dissolved oxygen, nutrients, biomass, phytoplankton, biochemical oxygen demand, etc.) were not included in the paper, it offered background information and a snapshot in time for water quality model support.

Study Objectives

The objective of this research is to address the following questions identified by the Science Panel as critical to understanding the historical condition of Utah Lake with respect to nutrients and ecology:

- What were the historical phosphorus, nitrogen, and silicon concentrations as depicted by sediment cores? (Science Panel charge 1.2, Attachment B).
- What does the diatom community and macrophyte community in the paleo record tell us about the historical trophic state and nutrient regime of the lake? (Science Panel charge 1.1, Attachment B)
  - Can diatom (benthic and planktonic) and/or macrophyte extent or presence be detected in sediment cores? And if so, what are they?
  - What were the environmental requirements for diatoms and extant macrophyte species?
  - How have environmental conditions changed over time?
- What do photopigments and DNA in the paleo record tell us about the historical water quality, trophic state, and nutrient regime of the lake? (Science Panel charge 1.4, Attachment B)

Expected Outputs and Outcomes

Specific outputs are expected to include, but are not limited to, a sampling and analysis plan (SAP), the project dataset, and a technical report with detailed results for all tasks. All data collected for this project must be made available to the Science Panel per the deliverable dates schedule in Section 6 of this RFP.

When this study is completed, the Science Panel will be able to answer the study objectives listed above and understand, with greater certainty:

- Historic nutrient and relevant elemental conditions (including analysis of relative availability of bound fractions); to include, at a minimum, Fe, Ca, Al, and other relevant elements as deemed appropriate by proposers

- Historic isotopic ^{15}N and ^{13}C conditions, and others as deemed appropriate
- Historic water clarity conditions
- Historic macrophyte presence, extent and quantity
- Historic diatom assemblage composition
- Inferred historic trophic state
- And, to the extent possible, inferred pH and thermal environmental conditions

3 Supporting Materials

A number of reports and documents were developed during the course of the ULWQS and previous study efforts on Utah Lake. These documents are provided as attachments for reference during response development. Additional ULWQS information including data, reports, meeting summaries, meeting recordings, and other related materials are available at utahlake.deq.utah.gov. A list and brief description of the relevant materials is included here:

Attachment A. Stakeholder Process https://documents.deq.utah.gov/water-quality/watershed-protection/utah-lake/DWQ-2017-004494.pdf. This document prescribes the structure, objectives, and duties of the Steering Committee, Science Panel, and other organizations with a role in the ULWQS. This process is directed by an independent professional facilitation team.

Attachment B. ULWQS Phase 2 Purpose and Initial Charge to Science Panel from Steering Committee. This document describes the Initial High Level Charge questions developed by the Steering Committee and an initial list of key questions designed to answer each high level charge https://documents.deq.utah.gov/water-quality/locations/utah-lake/DWQ-2019-001842.pdf.

Attachment C. Utah Lake Literature Review – This literature review was developed as a Phase 1 task and assessed the ability of existing literature and studies to answer the Initial High Level Charge questions presented in the ULWQS Phase 2 Initial Charge document. See select references in the Utah Lake Literature Review under *Topical Category 1: In-Lake Water Quality Conditions* for a list and findings of references relevant to historical conditions in Utah Lake. https://documents.deq.utah.gov/water-quality/locations/utah-lake/DWQ-2019-001842.pdf

Attachment D. Quality Assurance Program Plan for Environmental Data Operations, Final Plan, Revision No. 1.0, Effective September 5, 2014. https://deq.utah.gov/water-quality/quality-assurance-and-quality-control-program-monitoring-water-quality

References

Bolland, R. F. 1974. Paleoecological interpretation of the diatom succession in the recent sediments of Utah Lake. PhD. dissertation, University of Utah.

Brotherson, J.D. 1981. Aquatic and semiaquatic vegetation of Utah Lake and its bays. *Great Basin Naturalist Memoirs*: Vol. 5, Article 5.

Bushman, J.R. 1980. The Rate of Sedimentation in Utah Lake and the Use of Pollen as an Indicator of Time in Sediments.

Javakul, A., J.A. Grimes, and S.R. Rushforth. 1980. Diatoms in Sediment Cores in Utah Lake, Utah. U.S. Bureau of Reclamation WHAB Phase One Report #16.

Janetski, J. C. 1990. Utah Lake: its role in the prehistory of Utah Valley. Utah Historical Quarterly 58:5-31.

Macharia, A, N. 2012. Reconstruction of Paleoenvironments Using a Mass-Energy Flux Framework (Utah Lake). Doctoral dissertation. University of Utah. Salt Lake City, Utah.

4 Project Tasks

DWQ is seeking a qualified entity to provide technical support to the ULWQS Science Panel to assist with collecting information on the historic phosphorus, nitrogen, and silicon concentrations in Utah Lake as depicted by sediment cores. The tasks within this scope of work reflect a recommended approach for this work and are designed to help the proposer meet the study objectives and expected outputs and outcomes, which support the Science Panel in accomplishing its duties and fulfilling the Steering Committee's Charge (Attachment B). Proposers should feel free to include additional tasks in the proposal as they see appropriate to best achieve the study objectives and expected outcomes.

The deliverables for tasks presented in this Scope of Work will be reviewed collaboratively with the DWQ and ULWQS Science Panel. Prospective researchers will work closely with the Science Panel to perform each task and are expected to be responsive to any input and guidance provided by the Panel.

Task 1. Develop sampling and analysis plan (SAP)

A sampling and analysis plan (SAP) will be developed in accordance with the Utah DWQ's *Quality Assurance Program Plan for Environmental Data Operations, Final Plan* (Revision No. 1.0, see Attachment D). The essential elements for SAPs are listed in Appendix A of the *Quality Assurance Program Plan* and are as follows:

1. Introduction and background information
2. Objectives and design of the investigation
3. Special precautions and safety plan
4. Field sampling methods and documentation
5. Laboratory sample handling procedures
6. Analytical methods and laboratory documentation
7. Project quality control requirements
8. Data analysis, record keeping, and reporting requirements
9. Schedule and budget
10. Project team and responsibilities

Expected Deliverables

- Draft and final sampling and analysis plans in accordance with the Utah DWQ's Quality Assurance Program Plan for Environmental Data Operations, Final Plan.

Proposal Elements

Responses should:

- Provide demonstrated experience with developing sampling and analysis plans.
- Discuss a proposed approach for developing the deliverable for this task.

Task 2. Collect and preserve cores

Collection of cores across Utah Lake at locations optimized to characterize historic conditions across a variety of different lacustrine conditions from historic to present. Minimum core lengths should be sufficient to characterize substantial pre-settlement as well as post-settlement conditions up to the present, including the effects of historic lake level changes. Proposers should discuss core location strategies to maximize overcoming sediment mixing issues. Cores should be preserved for future analysis.

Expected Deliverables

- Replicate cores
- Preserved cores for future analysis

Proposal Elements

Responses should:

- Provide demonstrated experience with the collection of lacustrine sediment cores
- Discuss a proposed approach for developing the deliverable for this task.

Task 3. Analyze cores

Analysis of the cores, including dating of cores, nutrient, elemental, and isotopic composition, and historic diatom and macrophyte condition. Application of well-established techniques will be preferred over development of exploratory or experimental techniques, and proposers should explain and defend the method chosen.

Expected Deliverables

- An electronic dataset for each of the following items at the completion of analysis.
    - Dates for core segments at reasonable resolvable intervals
    - Elemental composition of core segments at reasonably resolvable intervals including:
        - At a minimum: P, N, and Si concentrations in Utah Lake
        - Ca, Fe, Al, total and organic C and isotope (^{15}N, ^{13}C) concentrations, and others as recommended by proposer
        - Forms of P in sediments and how that can/cannot be resolved (at a minimum, bulk and water-extractable phosphorus)

- Identification of historic diatom and macrophyte assemblage indicators along reasonably resolvable intervals.
- Photopigment analysis of core along reasonably resolvable intervals.
- eDNA interpretation along historic sequence, if justified for use as a measure to answer the problem statement. DWQ believes that application of eDNA approaches may be somewhat experimental or exploratory. At this time, the DWQ is mostly interested in applying proven and trusted techniques. Applicants wishing to use eDNA or other more exploratory techniques are asked to justify the value and defensibility of those approaches to this project.

Proposal Elements

Responses should:

- Provide demonstrated experience with lake core dating, nutrient, and elemental composition including forms of P in lake cores, N isotope composition in lake cores, historic diatom and macrophyte assemblage analysis techniques in lake cores, photopigment analysis of lake cores, eDNA analysis in lake cores, and any other applicable techniques deemed relevant and defensible that would provide additional strength to meeting the project objectives.
- Discuss a proposed approach for developing the deliverables for the following subtasks:

  Task 3.1: Dating cores

  Task 3.2: Nutrient, elemental, and isotopic composition of cores

  Task 3.3: Historical diatom and macrophyte community record

  Task 3.4: Photopigments

  Task 3.5 (option): eDNA

Task 4. Inferred historical condition analysis

In this task, proposers are asked how they will use the analyses conducted in Task 3 to recreate the inferred historical physical, chemical, and biological conditions outlined in the *Study Objectives* and *Expected Outputs and Outcomes* sections. As above, proposers are encouraged to discuss potential impediments to inference and interpretation, such as wind mixing and mixing of sediments, and how they will be overcome.

Expected Deliverables

Estimates, with uncertainty, on historic conditions including:

- Historic nutrient and relevant elemental conditions (including analysis of relative availability of bound fractions) to include, at a minimum, Fe, Ca, Al and other relevant elements as deemed appropriate by proposers

- Historic isotopic total and organic C, total N, ^{13}C, and ^{15}N conditions, and others as deemed appropriate
- Historic water clarity conditions
- Historic macrophyte presence, extent and quantity
- Historic diatom assemblage composition
- Inferred historic trophic state
- To the extent possible, inferred pH and thermal environmental conditions

Proposal Elements

Responses should:

- Provide demonstrated experience with conducting paleolimnological reconstruction analyses necessary to meet the expected deliverables.
- Discuss a proposed approach for developing the deliverables for this task.

Task 5. Prepare technical report

For this task, proposers will compile the methods, results, and historic inferences used in Tasks 2–4 into one comprehensive report for review by the Science Panel. Proposers should prepare a draft and final report based on feedback from the Science Panel. The report must include the methods, results, and discussion that answers the study objectives.

Expected Deliverables

- Draft and final technical reports

Proposal Elements

Responses should:

- Provide demonstrated experience with developing technical reports of this nature.
- Discuss a proposed approach for developing the deliverable for this task.

5 Key Personnel

Grant proposals should discuss in detail the team members proposed for each task, their directly related experience and expertise, and the allocation of effort among team members. Responses must detail the allocation of proposed hours for each task and team member in the table below. Please also include team members and time allocation for project management, project support such as technical editing and GIS, and other allocations not directly associated with the tasks and deliverables presented in this scope.

Task #	Deliverable	Team Member (hours)	Team Member (hours)	Team Member (hours)	Team Member (hours)
1	Deliverable 1				
	Deliverable 2				

6 Deliverables and Preliminary Due Dates

Deliverable due dates are based upon days from the contract award date. The project and all deliverables must be completed with consideration of the milestones in the table below, the scope of work response, and the final work plan after scope award. Any change in the execution date of the contract must result in a mutually agreed upon change in deliverable dates. All final products generated by the contractor will be transmitted to DWQ in a mutually agreed upon format prior to the expiration of the contract.

Task	Deliverable	Due Date
Task 1 – Develop Sampling and Analysis Plan	Draft sampling and analysis plan (SAP) Final SAP	14 days after scope award 30 days after scope award
Task 2 – Collect and Preserve Cores	Replicate cores	70 days after scope award
	Preserved cores	80 days after scope award
Task 3 – Analyze Cores	Electronic datasets	125 days after scope award
Task 4 – Inferred Historical Conditions Analysis	Estimates on historic conditions	160 days after scope award
Task 5–Prepare Technical Report	Draft technical report Final technical report	190 days after scope award 210 days after scope award

7 Science Panel Collaboration and Data Sharing

Grant recipients are required to complete this scope of work in collaboration with the ULWQS Science Panel. Grant recipients will:

- Develop the final research work plan in consultation with the Science Panel;
- Be responsive to Science Panel input on the final approach, work plan, work plan execution deliverables, results, analysis, final report, and any other interest to the Science Panel;
- Make all data and information collected by this grant, or funded by the ULWQS, available to the Science Panel within 45 days of field or laboratory analysis.

8 Evaluation and Award

Offers will be evaluated based on the following criteria listed in relative order of importance:

Selection Criteria	Weight
Key Personnel proposed for project work (experience, expertise, and reliability) and experience of specific team members proposed for discrete tasks	20%
Method of approach and proposer's ability to perform the requirements of the grant	20%
Demonstrated understanding of work elements in the context of existing products, the Utah Lake ecosystem, and the Science Panel Initial Charge	20%
Proposed approach for Science Panel collaboration and data sharing	20%
Price	20%

9 Cost Proposal Form

Offers must include a cost proposal utilizing the format provided below. Please ensure the cost proposal can be removed from the proposal for independent evaluation by including it as an attachment to the proposal or as a separate section at the end of the proposal. Note that indirect costs may not exceed 10% on contracts with other state and local governmental agencies, including colleges and universities.

Task #	Deliverable	Proposed Cost (USD)
Total		

10 Instructions for Grant Proposal Preparation

Proposals must include the following elements to qualify:

1) Proposals must follow the proposal template presented in Section 11
2) Proposals must:
    a. Include a discussion of successfully completed projects relevant to the specific deliverables in this scope of work;
    b. Demonstrate that proposed team members have direct experience with and are qualified for conducting the specific tasks and deliverables for which they are proposed. Team member qualifications and resumes must be included as an appendix to the proposal. Resumes will not be counted against the proposal page limit;
    c. Specify all project roles for the proposed team members including, but not limited to, project management, analytical tasks, GIS, technical editing, and any other proposed roles;
3) Proposed approach for how each task will be performed to achieve the purpose and deliverables outlined in this Scope of Work. Applicants may propose supplemental work elements necessary to achieve the expected outputs and outcomes;
4) Schedule for key milestones and deliverables;
5) A table of estimated level of effort for each team member by task utilizing the provided template (in Section 5); and
6) A stand-alone cost proposal table utilizing the provided template (Section 0) to include key personnel rates, hours and rates for completing specific tasks and deliverables, total proposed hours, indirect costs, overhead, and total cost.

11 Proposal Template

1. Experience and Expertise
   1.1. Related project experience
   1.2. Experience and expertise of key personnel
2. Proposed Approach
   2.1. Task 1 (repeat for each task)
      2.1.1. Key team members
      2.1.2. Approach discussion
         2.1.2.1. Approach for required Scope of Work deliverables
         2.1.2.2. Supplemental approach
         2.1.2.3. Task milestones and deliverables
3. Approach for Science Panel Collaboration and Data Sharing
4. Project milestones and deliverables
   4.1. A table of project milestones and deliverables
5. Level of effort
   5.1. A table with level of effort estimates
6. Cost Proposal
   6.1. A stand alone cost proposal table
7. Resumes (not counted toward page limit)
8. Related Case Study (not counted toward page limit)

12 Notice to Proceed

Notice to proceed will be provided by DWQ after receiving a signed grant agreement and Science Panel approval on the final work.