UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Water Quality Modeling to Support Utah Lake Water Quality Study

1 Introduction

The Utah Department of Environmental Quality, Division of Water Quality (DWQ) is entering into a contract to provide water quality modeling services to support the Utah Lake Water Quality Study (ULWQS).

2 Contract Term

The ULWQS is expected to be completed in December 2023; however, the contract period for this RFP is three (3) years, with 2 optional 1-year renewals subject to the State's discretion to accommodate future modifications in the project timeline. The tasks outlined in the scope of work are subject to availability of funds. This project may result in additional work plans and budget amendments, but are not guaranteed.

3 Background

The Utah Division of Water Quality (DWQ) is in 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 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. This Scope of Work will apply a set of water quality models to assist the Science Panel with developing responses to the Steering Committee charge questions. 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.

The Science Panel must complete a significant number of tasks to achieve its purpose of guiding the development of nutrient criteria 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

3.1 Introduction

Mechanistic water quality models are often utilized as one line of evidence when establishing numeric nutrient criteria. The Science Panel has determined that a mechanistic lake model would help to meet the objectives of the ULWQS. In addition, it is anticipated that a watershed model coupled to the lake model will be useful in evaluating historic, current and future loading to Utah Lake and help support future waste load allocations for permitted facilities to meet the adopted numeric nutrient criteria.

3.2 Existing Data and Information

A water quality model selection process led by DWQ and with stakeholder involvement was completed in 2016. A coupled modeling approach was selected for Utah Lake with the Environmental Fluid Dynamics Code (EFDC) program simulating hydrodynamics and the Water Quality Analysis Simulation Program (WASP) simulating water quality. The coupled EFDC-WASP model is referred to as the Utah Lake Nutrient Model (ULNM).

Subsequently, DWQ and EPA Region 8 signed a Memorandum of Understanding to collaborate with a research team from the University of Utah (UU) to build and calibrate the ULNM. The model development by the UU team was completed in consultation with the Science Panel. In early fall of 2020, the EFDC-WASP models and documentation were submitted to DWQ and the Science Panel.

Through analysis of sediment dynamics in Utah Lake, it was determined that a wind wave model to simulate the effect of wave action on shear stresses on the lake bottom was required. A conceptual diagram of model coupling is provided below.

A watershed modeling platform has not been selected to integrate with the ULNM. Other entities have conducted modeling efforts over portions of the watershed, but no unified water quality model is known to exist of the entire watershed.

A schematic of the modeling framework is shown in Figure 1.

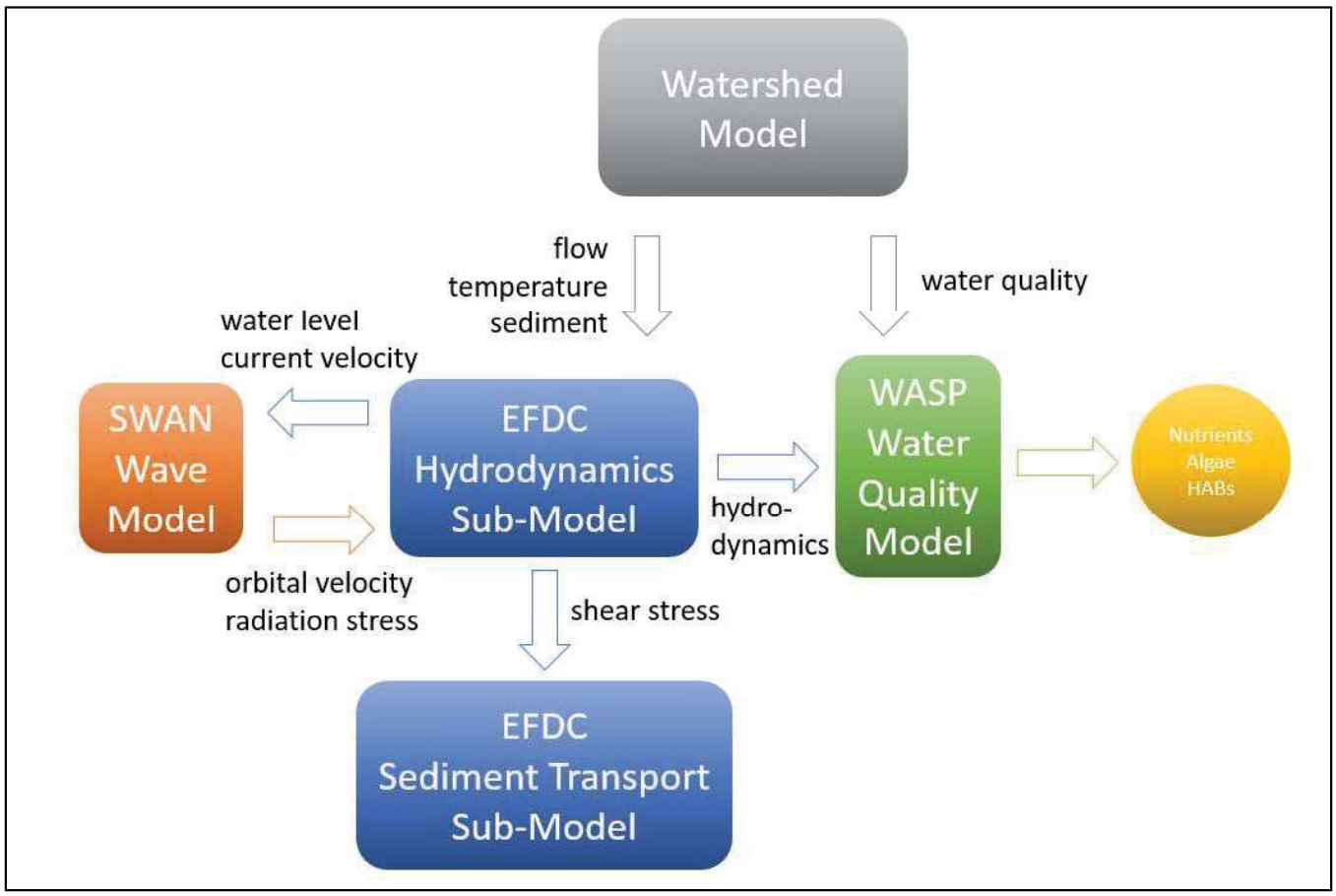

Figure 1: Utah Lake Water Quality Study Modeling Framework.

3.3 Problem Statement

Based on a review of the ULNM and accompanying documentation, the Science Panel identified and prioritized gaps and limitations in the ULNM that were summarized in a memorandum prepared by DWQ. Several refinements and enhancements to the UNLM will be required for the model to be considered suitable for application to numeric nutrient criteria establishment.

The loading of nutrients to Utah Lake have not been fully characterized due to the large number of inflow points to the lake and the difficulty with quantifying and sampling non-point sources such as stormwater and irrigation return flows. DWQ and the ULWQS need a watershed model both to characterize nutrient loading to Utah Lake and support the evaluation of nutrient load reduction scenarios to meet the adopted numeric nutrient criteria.

3.4 Study Objectives

The objective of this study will be to address the gaps and limitations in the ULNM identified by the Science Panel and to support the Science Panel in establishing numeric criteria for nitrogen and

phosphorus. Additionally, a watershed model is required to support with implementation of nutrient load reductions.

Study objectives are:

1. Provide technical expertise to the Science Panel in the areas of mechanistic hydrodynamic, water quality and watershed modeling.
2. Further refine and develop the ULNM so that it is a scientifically defensible decision support tool for establishing Numeric Nutrient Criteria (NNC).
3. Quantify the uncertainty of the ULNM in predicting nitrogen and phosphorus concentrations, and associated algal and cyanobacterial biomass response in order to build confidence in model outputs and application to NNC.
4. Apply ULNM to support determination of NNC concentrations.
5. Develop and calibrate a watershed model to be used as a scientifically defensible decision support tool for evaluating nutrient load reduction scenarios.
6. Apply watershed model for evaluation of nutrient load reduction scenarios.

3.5 Expected Outputs and Outcomes

Expected outputs include:

1. Enhanced lake model suitable for application to NNC
2. Watershed model suitable for application to waste load allocations
3. Uncertainty analysis
4. Calibration/validation
5. Evaluation of scenarios

4 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 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:

- Stakeholder Process. 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.
- 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.
- *Utah Lake Nutrient Model Selection Report* (2016): The Model Selection Report was prepared by DWQ and provides the evaluation and rationale for the recommended modeling program.

- *Quality Assurance Project Plan (QAPP) for Utah Lake EFDC/WASP Model Development, Modification, Evaluation and Application to Utah Lake Water Quality Study* (2019): The Model QAPP was jointly prepared by UU and DWQ.
- *Utah Lake Hydrodynamic (EFDC) and Water Quality (WASP) Model Report* (2020): The Model Report was jointly prepared by UU and DWQ, and includes a description of model build, sensitivity analysis and model calibration.
- Model Gaps and Limitations Memorandum (Draft, 2020): Memorandum prepared by DWQ that summarizes the Utah Lake Nutrient Model gaps and limitations to support the ULWQS as identified by the Science Panel.
- *Utah Lake Water Quality Study – Conceptual Models* (2020): Prepared by Tetra Tech, Inc. Based on direction from the Science Panel, the Conceptual Model document describes the nutrient effects in Utah Lake and relative extent to which the ULNM captures the described pathways.
- *Utah Lake Water Quality Study - Strategic Research Plan* (Draft, 2020): Prepared by Tetra Tech, Inc. Based on direction from the Science Panel, the Strategic Research Plan identifies and prioritizes research projects to support the objectives of the ULWQS.
- *Utah Lake Water Quality Study – Uncertainty Guidance* (2020): Prepared by Tetra Tech, Inc. Based on direction from the Science Panel, the Uncertainty Guidance describes how scientific uncertainty will be characterized and quantified to support the objectives of the ULWQS.
- *Utah Lake Water Quality Study – Analysis Update* (Draft, 2020): Prepared by Tetra Tech, Inc. based on direction from the Science Panel, the Analysis Update provides methods and results of scientific topics to support the objectives of the ULWQS.
- *Utah Lake Water Quality Study –Numeric Nutrient Criteria Technical Framework (Draft, 2020)*: Prepared by Tetra Tech, Inc. Based on direction from the Science Panel, the NNC Framework describes the empirical and mechanistic modeling approaches for deriving in-lake nitrogen and phosphorus NNC.

5 Scope of Work

Contractor shall provide technical support to the ULWQS Science Panel by conducting hydrodynamic and water quality modeling of Utah Lake and associated watershed. The tasks within this Scope of Work are designed to ensure that the modeling meets the study objectives and expected outputs and outcomes.

The deliverables for each task in this Scope of Work will be reviewed collaboratively by DWQ and the ULWQS Science Panel. The selected consultant will work at the direction of DWQ and the Science Panel to perform each task and is expected to be responsive to the input and guidance provided by the Science Panel.

The tasks are sub-divided into lake model, watershed model, and project reporting and administration sections.

5.1 Lake Model Tasks

The tasks described in this section are for enhancement and application of the Utah Lake Nutrient Model.

Task 1A: Review Existing Lake Model and Documentation

This task involves testing the existing model and reviewing associated documentation in order to develop recommendations and strategies for model modifications, refinements and enhancements to address limitations identified in the Model Gaps and Limitations Memorandum and meet the objectives of the ULWQS.

Statement of Work

At a minimum, the following model elements shall be assessed:

1. QA/QC of existing models
2. Evaluation of current model data
    a. Model grid
    b. Boundary conditions
    c. Initial condition data
    d. Model runtime

At a minimum, the following models and documents shall be included in the review:

1. Model QAPP
2. Model Report
3. Model Gaps and Limitation Memorandum
4. EFDC-WASP model of Utah Lake for water years 2006-2015.
5. ULWQS Conceptual Models
6. ULWQS Strategic Research Plan
7. ULWQS Analysis Update
8. ULWQS Uncertainty Guidance

9. ULWQS NNC Framework

Based on the review of the model and associated documentation, the Model QAPP shall be revised as necessary based on the specific requirements of the ULWQS.

Deliverables

1. Technical memorandum with recommended modeling strategies and priorities to incorporate modifications, refinements, and enhancements to address model limitations/deficiencies and results from initial model testing.
2. QA/QC Excel workbooks.
3. Draft and final Revised Model QAPP, as needed.

DWQ Responsibilities

1. Provide contractor with all documentation, models and supporting materials.
2. Compile and provide one set of non-conflicting comments from DWQ and the Science Panel based on the review of draft submittals.

Task 1B: Application of Existing Lake Models

This task involves implementing the existing EFDC-WASP models in their current form to the extent allowed by the results of Task 1A and the associated level of uncertainty for each application.

Statement of Work

Potential applications will be identified by the Science Panel and may include: inflow data evaluation, particle tracing, assess impacts of circulation, water age, and retention time.

Deliverables

Technical memorandum with the list of model applications executed under Task 1b and a description of modeling approach, uncertainty, and assumptions or limitations. Animated output shall be provided for specific model applications, such as water age, retention time, and circulation patterns, as needed.

Task 2: Lake Model Enhancements

This task involves enhancing the capabilities of the model in order to meet the objectives of the ULWQS.

Statement of Work

The following enhancements identified by the Science Panel as documented in the Modeling Gaps and Limitations Memorandum shall be implemented:

1. Build, calibrate and couple a wind-wave model to the EFDC hydrodynamic model utilizing the Simulating WAves Nearshore (SWAN) model. To facilitate the linkage between models,

contractor shall implement Excel workbooks, FORTRAN, or Python scripts to automate the processing of EFDC and SWAN model outputs as deemed necessary.

2. Implement sediment diagenesis routine on all wet cells in the model domain. The sediment diagenesis model setup will be conducted using sediment nutrient composition data available from Utah Lake complemented, as necessary, with literature information from applications of the WASP sediment diagenesis model in similar water bodies. Contractor shall optimize the sediment diagenesis model setup to ensure that inorganic sediment nutrient fluxes predicted by the model are physically meaningful, capture typical seasonal patterns, and are balanced with the loading from the water column to avoid unrealistic long term trends in nutrient fluxes and model runtime inefficiency.
3. Implement simulation of pH and alkalinity as model state variables. Contractor will complete the pH model setup ensuring model simulations are physically meaningful and reasonable for the conditions of Utah Lake.
4. Improve model performance results and run-time associated with grid cells that undergo wetting and drying. The strategies to improve runtime and model performance will also consider the findings obtained from the QA/QC review of the ULNM conducted in Task 1a.

The source code for WASP is not currently made publicly available. Source code modifications to WASP will need to be made directly by EPA or with the permission of EPA.

Deliverables

1. Draft technical memorandum with description of the proposed model enhancements and final technical memorandum that includes description of how they were implemented.

DWQ Responsibilities

1. Provide contractor with observed wave height, period, and direction data for SWAN model calibration.
2. Compile and provide one set of non-conflicting comments from DWQ and the Science Panel based on the review of draft submittals.

Task 3: Lake Model Validation and Calibration Refinement

This task involves validating the model with an independent data set. Depending on the results of the model validation, additional model calibration refinement shall be conducted, as necessary.

Statement of Work

This task includes the following sub-tasks:

1. Identify and select the period of model validation and calibration refinement based on review and assessment of the available data. The period 2017 through 2020 will be used for model validation and further calibration efforts will focus on the period with the most available hydrodynamic and water quality data.

2. Gather and compile model input and validation data, including publicly available meteorological, hydrologic, and water quality data. Import lake validation data into Water Resources Database (WRDB) format compatible database.
3. Develop model inputs from compiled data and populate validation model.
4. Run model simulation and evaluate model performance using graphical and statistical measures as defined in the Model QAPP under Task 1a. Contractor will run the ULNM model for the period 2015 – 2020. The model validation will focus on statistical and graphical comparisons of model outputs and observed data during the period 2017 – 2020. The years 2015 and 2016 will be spin up years and will not be included in the performance evaluations to avoid undesired impacts of the initial conditions on the model outputs.
5. Verify light penetration and extinction prediction in the model utilizing water quality and light measurements collected by DWQ.
6. Depending on model performance during the validation period, additional calibration refinement may be required, as determined in consultation with the Science Panel. If calibration refinement is required, the most relevant hydrodynamic and water quality parameters and processes will be adjusted in order to improve model performance and to achieve the model performance metrics defined in the Model QAPP under Task 1a.

Deliverables

1. Technical memorandum with methods and results of model validation and calibration refinement.
2. Water Resources Database compatible format database, i.e. SQLite, MySQL.
3. Calibrated/validated model files.

Task 4: Lake Model Uncertainty Analysis

This task involves conducting an uncertainty analysis of the calibrated and validated model to quantify error associated with selected model outputs.

Statement of Work

Contractor shall perform an uncertainty analysis of the updated, enhanced, calibrated and validated ULNM to quantify the errors associated with selected model outputs. Contractor will coordinate with UDWQ and the SP to select the most appropriate method to conduct the uncertainty analysis of the ULNM consistent with the ULWQS Uncertainty Guidance Document. Potential methods for the model uncertainty analysis include:

1. Monte Carlo method
2. Marchov Chain Monte Carlo method
3. First Order Variance Analysis (FOVA) method

Deliverables

1. Technical memorandum with methods and results of the uncertainty analysis.

Task 5: Lake Model Application to Numeric Nutrient Criteria Development

This task involves applying the calibrated and validated model to support the development of numeric nutrient criteria for Utah Lake as described in the NNC Framework.

Statement of Work

The following model simulations will be conducted to meet the objectives of the ULWQS:

1. Simulation of historical reference conditions of Utah Lake prior to European settlement of Utah Valley. Contractor will run the ULNM with load reductions representing full removal of anthropogenic loadings from the watershed from point sources and nonpoint sources. The watershed model with mechanistic representations of point source and nonpoint source loading developed under Task 9 will be used to calculate the ULNM inputs. Historic nutrient concentrations being identified through the Paleolimnological study of the lake by Dr. Janice Brahney will be used to help validate reference model performance. Linkage alternatives to implement the watershed model to support the evaluation of natural or reference conditions in Utah Lake are presented under Task 10. Contractor will coordinate with UDWQ and the SP the most cost-effective and appropriate strategy to implement the watershed model to support the evaluation of reference conditions in Utah Lake.
2. Simulation of in-lake nitrogen and phosphorus concentrations that meet selected algal and cyanobacterial biomass endpoints. Boundary load conditions will be adjusted in order to determine the numeric nutrient criteria. Contractor will update the nutrient loading inventory by source to identify the percent contribution of loads from direct point sources, watershed boundaries, sediment nutrient fluxes, and/or atmospheric deposition. The selection of the load reduction scenarios and the simulation period for the analyses will be defined in coordination with UDWQ and the SP.

Deliverables

1. Technical memorandum with methods and results of the application of model to NNC scenarios.

Task 6: Lake Model Documentation and Training

This task involves documentation of the ULNM and training of DWQ staff in its use.

Statement of Work

Specific sub-tasks include:

1. Preparation of a Lake Model Manual document for the ULNM which contains the necessary information for DWQ to maintain and operate the model.
2. Training of DWQ staff in how to interact with and run the model, and view model output will be conducted. Assumed three day virtual training session for purposes of fee estimate.

Deliverables

1. Draft and final Lake Model Manual
2. Training of DWQ staff.
3. Final EFDC and WASP models and associated documentation.

5.2 Watershed Model Tasks

The tasks described in this section are for the model of the watershed draining to Utah Lake. The model to be implemented will be selected as part of this scope of work. The scope of work and fee were developed assuming HSPF, SWAT, or other model of similar complexity would be implemented.

The spatial extent of the watershed tributary to Utah Lake is shown in Figure 2. The watershed model shall simulate water quantity and quality within the entire watershed and account for inter-basin transfers of water from the Colorado River and Weber River watersheds.

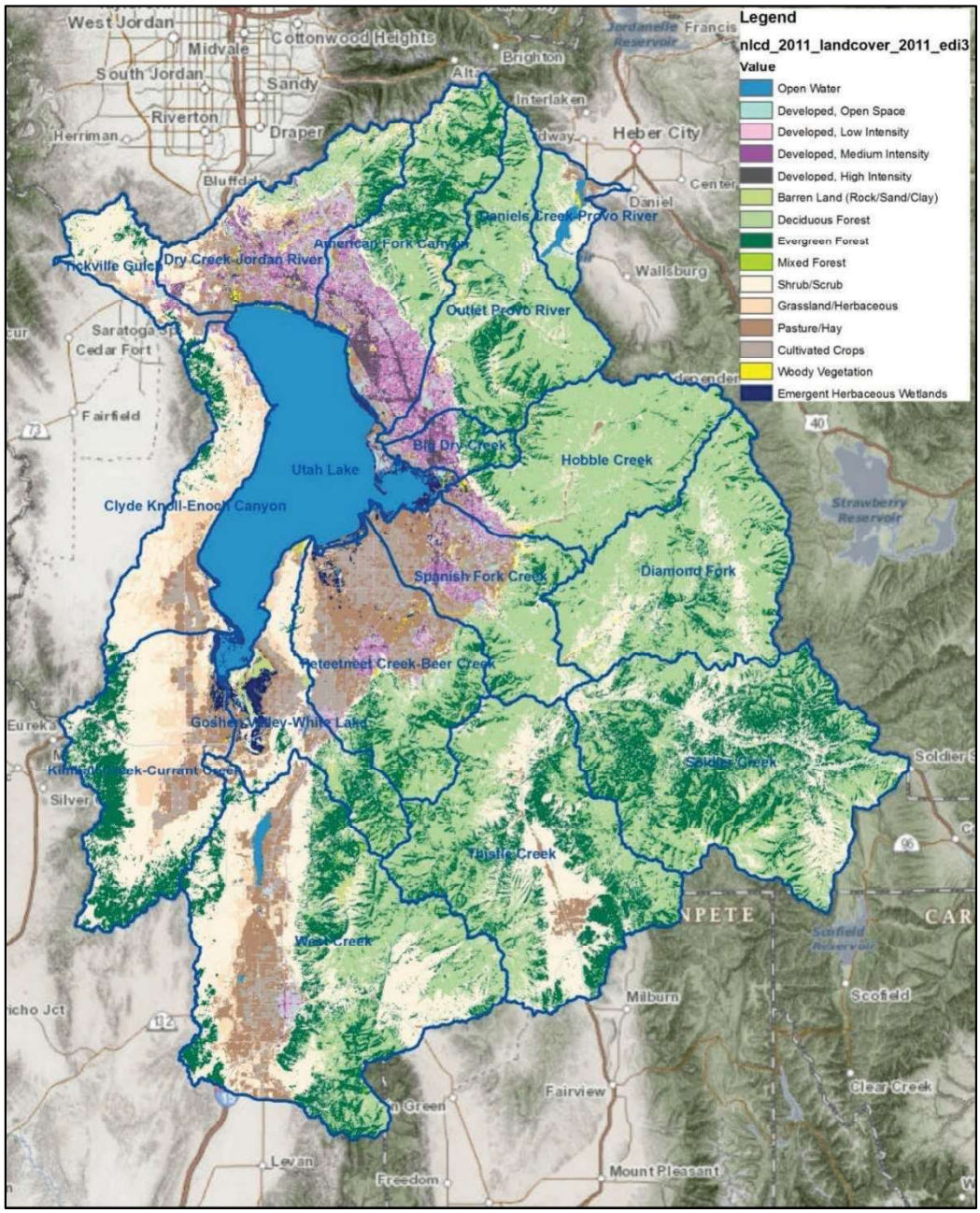

Figure 2: Utah Lake Watershed Map

Task 7: Watershed Model Selection and Approach

This task involves conducting a selection process to evaluate possible watershed modeling platforms and to select the watershed model that will be implemented in order to best meet the study objectives.

Statement of Work

In consultation with the Steering Committee and Science Panel, contractor shall develop model objectives, selection criteria, model ranking and final selection. The primary objective of the watershed model developed under Task 7 is to evaluate point and nonpoint source load reduction scenarios. Therefore, a unified model that is capable of reasonably simulating loads from all watershed sources will be selected. Models that are better able to explicitly simulate individual load reduction practices are also preferable because they will make it easier to link the chosen practices with potential costs. The selected watershed modeling framework may include multiple platforms, such as SWAT or APEX for agricultural lands combined with a watershed model that covers the full extent of the Utah Lake drainage area (e.g., HSPF).

Deliverables

1. Technical memorandum with model objectives, selection criteria, model ranking and final selection recommendation.

Task 8: Watershed Model QAPP

This task involves developing the Quality Assurance Project Plan (QAPP) for watershed model implementation.

Statement of Work

The QAPP shall be prepared in accordance with U.S. EPA's *Guidance for Quality Assurance Project Plans for Modeling (EPA QA/G-5M)* (USEPA, 2002), which discusses strategies to ensure that prediction-based tools are quality built to support environmental decision-making. QAPP development will include data quality objectives (DQOs) for the modeling project. The DQOs will be focused around the principal study questions that define DWQ's decision needs. Criteria for model inputs/outputs will be in accordance with the seven steps described in EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4)* (USEPA, 2006). Elements of the QAPP shall include model needs and requirements analysis, data quality objectives, existing data compilation, data gaps identification, data collection plan, model development and application plan, and model performance criteria.

Consideration shall be given for coupling the watershed model to the lake model.

Deliverables

1. Draft and final Watershed Model QAPP.

DWQ Responsibilities

1. Compile and provide one set of non-conflicting comments from DWQ and the Science Panel based on the review of draft submittals.

Task 9: Watershed Model Development

This task involves building and calibrating/validating the model and conducting any sensitivity/uncertainty analyses per the procedures described in the QAPP.

Statement of Work

Contractor shall complete the following sub-tasks for the development of the watershed model:

1. Data Assembly - The data assembly task will involve identifying and gathering data for model development and calibration. Data to be compiled for model development and calibration includes, but are not limited to, meteorological data, atmospheric deposition data, satellite-based estimates of evapotranspiration and snow, digital elevation model (DEM), catchments and reaches, land cover and land use, soils and associated physical and chemical properties, flow and water quality monitoring locations and data, point source locations and data, and nonpoint source management data (e.g., crop planting dates).
2. Model Development – Development of the watershed model will involve subwatershed delineation, incorporating key attributes such as 303(d) listed segments, MS4 areas, flow and water quality monitoring stations, and major impoundments/lakes. Uplands will be defined using a hydrologic response unit (HRU) approach. An HRU is a unique combination of land use/cover, soil, slope, weather zone and/or other important defining feature.
3. Model Calibration and Validation – Available flow and water quality records will be used to conduct the model calibration. Model calibration will proceed through the maximization of model fit (as defined in the QAPP) simultaneously across multiple monitoring locations. This will be followed by model corroboration or validation in which the ability of the model to perform will be tested using data not applied in the calibration (e.g., alternative years). The hydrology calibration strategy will involve evaluating and calibrating the overall watershed water balance, evapotranspiration using satellite derived datasets such as from the Simplified Surface Energy Balance, and snow depth and water equivalent data from the National Snow and Ice Data Center's Snow Data Assimilation System. Water quality calibration will involve ensuring unit area loading rates are in alignment with the literature as well as calibration to instream observations for multiple constituents (e.g., orthophosphate) and locations.
4. Evaluation of Model Performance - Contractor will establish model performance criteria in the QAPP. Model evaluation will express model fit in terms of ranges that correspond to "very good", "good", "fair", or "poor" quality of fit. Model performance measures may include 1) percent difference (relative error) between simulated and recorded values for flow and water quality metrics (e.g., seasonal flows, concentrations), 2) relative absolute error and root mean square error, 3) Nash-Sutcliffe Coefficient of Model Fit Efficiency (for continuous time series), and 4) correlation coefficient (R) and coefficient of determination (R^2) between simulated and observed paired data.

5. Model Sensitivity and Uncertainty Analysis. Contractor will conduct model sensitivity and uncertainty analyses by testing various assumptions that have a significant impact on model results.

Deliverables

1. Technical memorandum with methods and results of watershed model build and calibration/validation.
2. Technical memorandum with methods and results of watershed model sensitivity/uncertainty analysis.

DWQ Responsibilities

1. Provide contractor with data collected by DWQ that would support watershed model build and calibration.
2. Support contractor in obtaining other information that would support watershed model build and calibration (e.g., inter-basin transfers of water from the Colorado River and Weber River watersheds).

Task 10: Watershed Model Application to Nutrient Load Reduction Scenarios

This task involves applying the calibrated and validated model to support nutrient load reduction scenario analysis. Tetra Tech will run 3 to 6 scenarios, depending on the type and complexity of each scenario.

Statement of Work

The watershed model will be linked to the lake model in order to meet the objectives of the ULWQS.

Three alternative strategies for linking the watershed model to the lake model with different levels of integration will be considered.

1. Full direct - Flow and water quality from the calibrated watershed model serve as direct inputs to lake model
2. Partial direct - Maintain some observation-derived lake boundary inflows and supplement with select flow and/or water quality from watershed model
3. Indirect - Maintain observation-derived boundary inflows for current conditions; for scenarios adjust based on watershed model predictions of relative change

The three coupling options will be evaluated based on watershed model performance and uncertainty, available data to define lake boundary conditions, and near-term and long-term project needs. A coupling strategy will be recommended and discussed with UDWQ, SC and SP prior to scenario applications.

The following model simulations will be conducted to meet the objectives of the ULWQS:

1. Simulation of historical reference conditions of the Utah Lake watershed prior to European settlement of Utah Valley. For this scenario, existing land use/covers influenced by anthropogenic activities in the drainage area (e.g., urban development, crop cultivation) will be reconfigured to represent natural vegetation in the watershed. Natural vegetation characteristics will be informed by LANDFIRE's biophysical settings geospatial coverage that depicts vegetation types predominant on the landscape prior to Euro-American settlement, including the effects of natural fire regime. Anthropogenic activities represented in the current conditions model (e.g., irrigation, water withdrawals, point sources) will be removed. Available data to inform pre-European settlement hydraulics and the drainage network will be reviewed for incorporation into the scenario.
2. Simulation of nitrogen and phosphorus load reduction scenarios from point and non-point sources that meet selected nutrient, algal and cyanobacterial biomass endpoints. These scenarios involve a suite of simulations that evaluate individual or collective reductions from point and nonpoint sources. Nutrient loads will be tabulated based on current conditions simulated by the model, either at-source and/or delivered to Utah Lake, potentially by season, land use/cover category, and/or jurisdiction. The nutrient reduction scenarios may include simulation of nitrogen and/or phosphorus effluent limits for UPDES permitted point sources in the watershed and/or evaluate BMP implementation in urban stormwater quality.

Deliverables

1. Technical memorandum with methods and results of nutrient load reduction scenarios.

Task 11: Watershed Model Documentation and Training

This task involves documentation of the ULNM and training of DWQ staff in its use.

Statement of Work

Specific sub-tasks include:

1. Preparation of a Watershed Model Manual document which contains the necessary information for DWQ to maintain and operate the model.
2. Training of DWQ staff in how to interact with and run the model, and view model output. Assumed three day virtual training session for purposes of fee estimate.

Deliverables

1. Draft and final Watershed Model Manual
2. Training of DWQ staff
3. Final watershed models and associated output

DWQ Responsibilities

1. Compile and provide one set of non-conflicting comments from DWQ and the Science Panel based on the review of draft submittals.

5.3 Project Reporting and Management Tasks

The tasks described in this section are applicable to both the lake and watershed modeling efforts.

For all technical memorandum deliverables in this Scope of Work, a draft version for review may be requested by DWQ. If a draft submittal is requested, DWQ will compile and provide one set of non-conflicting review comments from DWQ, the Science Panel and/or the Steering Committee.

Task 12: Utah Lake Water Quality Study Model Reports

This task involves summarizing the modeling efforts as documented in the Technical Memorandums and preparing the relevant sections in reports to support the Utah Lake Water Quality Study.

Statement of Work

The following reports or sections of reports will be prepared:

1. Model Report compiling the previously prepared Technical Memorandums.
2. Modeling section in the Numeric Nutrient Criteria Technical Support Document that provides the technical basis for the criteria determination.
3. Modeling section in the Implementation Evaluation Report that provides a cost analysis of nutrient reduction scenarios to meet the NNC.

Deliverables

1. Model Report compiling the previously prepared Technical Memorandums.
2. Modeling section(s) of the Numeric Nutrient Criteria Technical Support Document.
3. Modeling sections(s) of the Implementation Evaluation Report.

Task 13: Steering Committee and Science Panel Interaction

This task involves interacting with the ULWQS Steering Committee and Science Panel, including participation in and presentations at meetings, preparation and submittal of requested analyses, and other communication.

Statement of Work

Steering Committee and Science Panel meetings are currently being conducted virtually and do not require travel; however, this is subject to change and the Contractor may be requested to attend in person meetings in the future. It is understood that Tetra Tech's cost estimate did not include any travel costs to attend Steering Committee and Science Panel meetings and additional funds will be needed to attend meetings if that ends up becoming necessary.

This Scope of Work will be completed under the advisement of the ULWQS Science Panel. The contractor shall:

- Provide regular progress updates on all task work during the SP meetings in the form of progress updates, presentations, or other means, as requested;
- Be responsive to Science Panel input on the approach, work plan, work plan execution deliverables, results, analysis, report, and any other interest to the Science Panel;
- Assist the SP in communicating elements such as model development, scenario construction, outcomes, and implications of this work to the SC, where appropriate; and
- Make all data and model inputs and outputs generated by this Scope of Work, or funded by the ULWQS, available to the Science Panel within 45 days of analysis, as requested.

Deliverables

1. Participate at Steering Committee and Science Panel meetings with model-related discussions
2. 40 hours of ad-hoc Steering Committee and Science Panel model support

Task 14: Project Management

This task involves project management duties necessary for effective and efficient accomplishment of all tasks described in the Scope of Work, including project planning, direction, scheduling, and budgeting, participation in regular coordination meetings with DWQ, and providing project status updates.

Statement of Work

Tetra Tech will provide continuous and ongoing administrative oversight, including financial reporting and technical progress review. This will be summarized in monthly progress reports which will accompany monthly invoices.

Tetra Tech will establish regular biweekly calls for this project with, at a minimum, the project leaders for Tetra Tech and the Utah Project Management team. Other technical leads and the Tetra Tech principal will be brought in as requested for specific technical theme or contract management discussions.

Deliverables

1. Monthly financial tracking and progress reporting
2. Biweekly management calls

6 Project Schedule

The target completion date of this scope is 12/31/2023.

Target deliverable due dates are shown in the figure below assuming a notice to proceed of July 12, 2021. The project and all deliverables shall be completed with consideration of the milestones in the figure. Any change to the deliverable dates must be mutually agreed upon by DWQ and the Contractor.

All final products generated by the contractor will be transmitted to DWQ in a format that meets DWQ and the Science Panel needs prior to the expiration of the contract.

Table 1. Project Schedule and Deliverable Due Dates.

		2022																		2023											
Tasks		J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1A	Review existing lake model documentation																														
1B	Application of existing lake models																														
2	Lake model enhancements																														
3	Lake model validation/calibration refinement																														
4	Lake model uncertainty analysis																														
5	Lake model application to NNC development																														
6	Lake model documentation and training																														
7	Watershed model selection and approach																														
8	Watershed model QAPP																														
9	Watershed model development																														
10	Watershed model application to scenarios																														
11	Watershed model documentation and training																														
12	ULWQS reports																														
13	SC and SP interaction																														
14	Project management																														