WaterSMART

Applied Science Grants for Fiscal Year 2023

Notice of Funding Opportunity No, R23AS00446

Category B

Modeling the Impact of Stream Inflows on Water Quality under a Changing Climate

Applicant:

University of California Davis - Tahoe Environmental Research Center (TERC)

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NB – Following the NOF, the **technical proposal and evaluation criteria** sections are **less than 20 pages long**.

1. Executive Summary

Date: October 16, 2023

Applicant Name: University of California Davis, Tahoe Environmental Research Center (TERC)

City, County, State: Davis, Yolo County, California

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Applicant Category: B

Project Funding Request: $ 400,000. **Total Project Cost:** $ 547,077

Project Title: Modeling the Impact of Stream Inflows on Water Quality under a Changing Climate

Project Summary:

The physical interactions between inflowing streams and receiving waters (reservoirs and lakes) are poorly understood and represented in predictive models. This is of increasing concern under future climate change scenarios, where the underlying physical processes will change. The University of California (**UC Davis**), in partnership with the Incline Village General Improvement District (**IVGID**), will develop an **improved modeling tool** to allow for the improved **evaluation of changes in lake water quality due to stream-lake interactions**. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in stream water, and extreme lower lake levels. The project will be based at **Lake Tahoe**, CA-NV, where primary concerns are alterations in stream loading and the fate of the introduced nutrients, contaminants, and fine sediments. These changes can significantly influence water quality, trigger algal blooms, impact lake clarity, and ultimately affect **drinking water supply**. In other systems issues such as preserving a cold-water pool for salmon spawning success, reducing the occurrence of harmful algal blooms (HABs), and maintaining hypolimnetic oxygen would benefit from an improved modeling capacity. A key component of this project is the **collection of an unprecedented set of** stream-lake interaction **data** using a combination of an autonomous vertical profiler sampling every 10 minutes, an autonomous underwater vehicle (AUV) conducting horizontal measurement transects across the stream plume, and continuous vertical profile data. Sampling will happen at two streams at Lake Tahoe (Incline Creek and Ward Creek). This equipment will monitor stream-lake water interactions with high spatial and temporal resolution. With these data, it will be possible to revise existing algorithms to characterize the fate and dilution of streams into lakes which were based on simple laboratory measurements. The improved algorithms will be incorporated into the public domain, 3-D hydrodynamic and water quality model (Si3D) and calibrated and validated for Lake Tahoe. The resulting model will have the potential for broad application in lakes and reservoirs nationwide. Specifically, this study aims to: (1) Develop precise algorithms to comprehensively characterize interactions (dilution, insertion depths, horizontal advection) between stream and lake waters, integrating them into an existing 3-D lake model; (2) Evaluate the significance of physical processes, including transport, dilution, and deposition, in dictating the fate of incoming stream flows; (3) Characterize the spatiotemporal variations of stream inflows as they enter a lake; (4) Assess the potential consequences of wildfires and droughts on stream-lake interactions, particularly their repercussions on water quality at water treatment plant intakes; (5) Formulate actionable management strategies to effectively mitigate any adverse impacts identified through our research.

Approximate Length of the Project: 1.5 years from award project (Start date: October 2024)

Completion Date: April 2026

Federal Facility? The project is not located on a Federal Facility

2. Project Location

Lake Tahoe, beyond its iconic status as a waterbody of extraordinary ecological value and its designation as an Outstanding National Resource Water under the Clean Water Act, plays an important **water supply** role. It provides drinking water for a permanent population of ~50,000 people and an annual tourist population of ~15 million. To date, 6 public water systems in Lake Tahoe possess the filtration avoidance permit and represent 10% of the total systems under this status within the United States of America. This status is only given to water suppliers with outstanding, pure water. Outflow from Lake Tahoe passes down the Truckee River to Pyramid Lake, and releases from it (magnitude, timing, and quality) have a major impact on the water quality downstream. At Lake Tahoe, one of the major concerns is changes to the stream loading of nutrients and fine sediments to the lake, as they can impact water quality at water intakes, algal blooms, and lake clarity, ultimately affecting water supply for human consumption. These effects modify the ecological value of Lake Tahoe as an outstanding water resource.

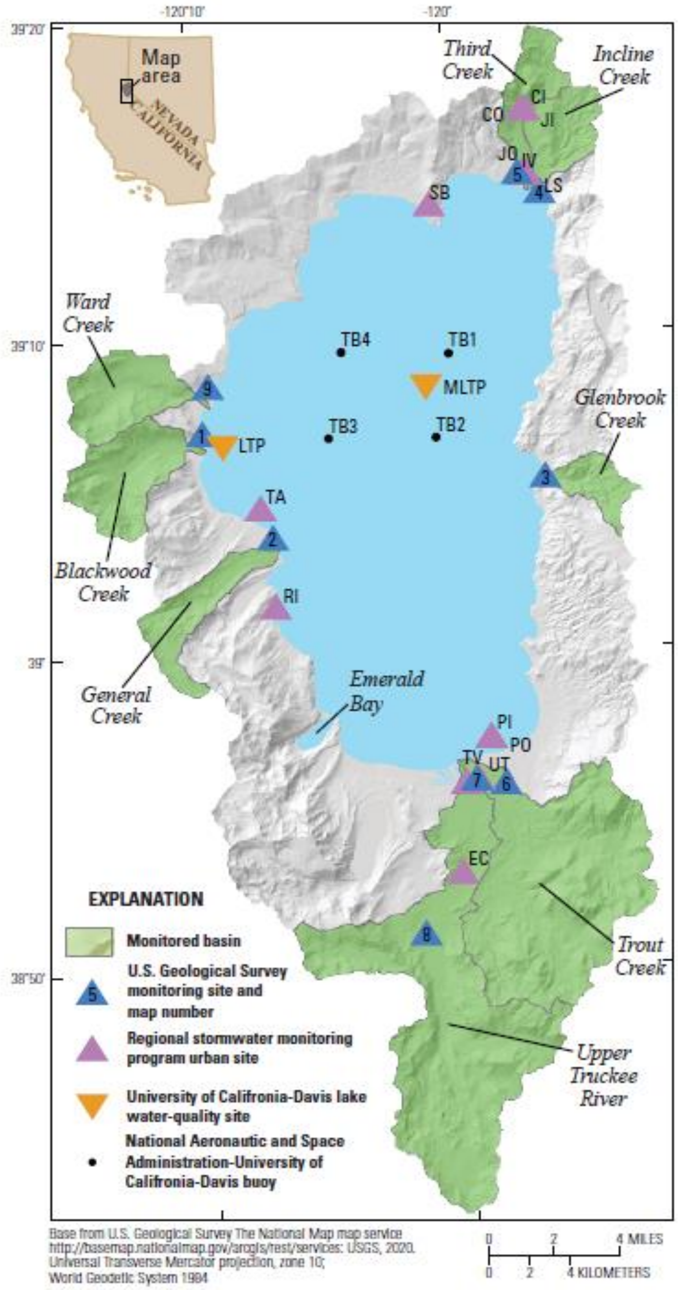

Fig. 1. Map of Lake Tahoe with some key monitoring stations in the lake and in the streams. Source: Taken from [Seasonal and Long-Term Clarity Trend Assessment of Lake Tahoe, California–Nevada](#) | July 2022

Some of the climate change impacts that will affect the stream-lake interactions are wildfires and extreme hydrological events (floods/droughts), which ultimately impact the ecological value and water supply reliability of the lake. Lake Tahoe is increasingly exposed to **wildfires**, which may increase the **stream loading** of nutrients, contaminants, and fine sediments washed out from the watershed and flushed into the lake. **Drought** events may cause large drops in the **lake level**, which may alter water quality at water intakes, necessitating changes to water treatment requirements. Through better predictive abilities of the stream-lake interactions and the water quality at the intakes, a broader range of management actions can be considered ahead of time.

Field observations will take place in Lake Tahoe, CA-NV given the large body of knowledge that already exists for the lake. Lake Tahoe has six gauged streams monitored by the USGS and three by UC Davis, a meteorological network operated by NASA and UC Davis, and a long-term nearshore monitoring network operated by UC Davis (Fig. 1). Lake Tahoe is a snowmelt-driven system with highly variable lake and stream conditions. Streams exhibit temperature changes within hours, and the lake water temperature exhibits highly dynamic conditions driven by daily stratification and winds (Roberts et al., 2018; Valbuena et al., 2022). The lake-stream interactions are known to take place within a relatively short distance of the shore ($< 1\ km$). Lake levels have changed more dramatically during the last decades (Fig. 2), reflecting the importance of considering drought effects in management actions. Instead of studying all the gauged streams at Lake Tahoe, we propose to focus on two of them: **Ward Creek** in Placer County, CA ($39°\ 10'\ 20''\ N,\ 120°\ 8'\ 20''\ W$), and **Incline Creek**, within Washoe County, NV, 36 $miles$ southwest of Reno ($39°\ 14'\ 45''\ N, 119°\ 57'\ 0''\ W$). We use the two inflows to account for differences in the inflow-lake interactions between a small steep sloped basin (Ward Creek) and a medium-sized gently sloped basin (Incline Creek). The latter is located near a water intake for water supply. By focusing on the underlying physics, the results will apply to a broad range of lakes and reservoirs nationwide. Most of the modeling and data analysis will take place at the UC Davis Tahoe Environmental Research Center in Incline Village, NV.

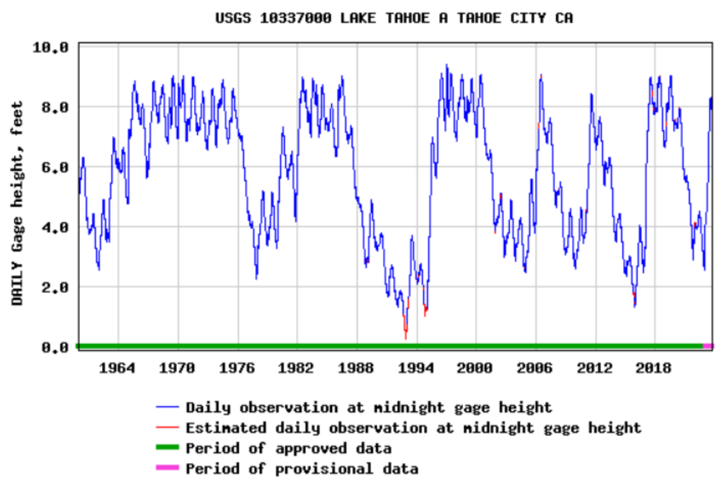

Fig. 2. Daily changes in the water surface elevation at Lake Tahoe between 1960 and today. The gage datum is at 6,220 ft. Lake natural rim is at 6,223 ft and the maximum legal limit is at 6,229.1 ft. Extracted from USGS database

3. Technical Project Description

3.1. Applicant Category Justification

University of California Davis (UC Davis) is a Category B applicant (University) who is acting in partnership with a Category A applicant: Incline Village General Improvement District, IVGID. IVGID provides the local knowledge of the water supply problems in Tahoe. They agree to the submittal and content of the application. Please, see the **9**. **Letter of Partnership** section for more information.

3.2. Background

Lake ecosystems are vital in the Earth's freshwater system, providing water resources for human consumption, supporting aquatic biodiversity, and regulating regional climate. **Stream inflows** are the primary water source for most lakes, and the fate of these inflows has **significant ecological and societal implications**. Inflows carry particulates and dissolved solutes which control the vertical distribution of light and nutrients. Stream-lake interactions govern the abundance and composition of algae and particulate distribution, which ultimately impact the freshwater ecological value for agricultural, municipal, tribal, and recreational uses via changes in lake clarity, algal growth, water quality, and delivery of microplastics, among others.

The **transport and dilution produced by stream inflows as they first enter lakes** are generally **poorly accounted** for. This is in part due to the continuous changes in the physical properties of the inflows and the receiving lake water. Stream temperatures can fluctuate by many degrees during the day (Cortés et al., 2014). In snow-fed systems, the stream flow rate can fluctuate by a factor of two on a timescale of hours and by orders of magnitude over weeks (Roberts et al., 2018). Lakes are simultaneously subject to diurnal stratification, and depending on meteorological conditions, the associated density stratification can change dramatically in a matter of days (Valbuena et al., 2022).

At the stream–lake interface, where these independently varying fluids come together, the external conditions of each water body will determine the degree of dilution. This interaction produces a time-varying, density-dependent, water plume entering as an overflow, underflow, or intrusions at multiple intermediate depths in the lake water column (Fischer et al., 1979). Simultaneously, the plume can be moved laterally in response to factors such as lake motions and dam operations, and larger water bodies may remain trapped close to the shore in response to rotational effects (Horner-Devine et al., 2015; Valbuena et al., 2022). As a result, quantifying the transport and dilution of river inflows into lakes is important for predicting water quality, nutrient cycling, and productivity in these aquatic ecosystems. All these parameters also alter treatment needs for drinking water supply depending on the **quality of the water at the intakes** (e.g., Horner-Devine et al., 2015; Hoyer et al., 2015a).

Under future, warming climate change scenarios, many governing **factors affecting stream-lake interactions are expected to change**. Climate change will reduce snowpack, leading to more rainfall, and rain-on-snow events, and result in earlier peak hydrographs (Sadro et al., 2019). These will increase stream flow peaks, change river temperatures, and accelerate erosion and contaminant loads (Ficklin et al., 2013). Lakes themselves will also change. Overall, lake water temperatures are becoming warmer, stratification periods are extending, and mixing frequency is decreasing (Sahoo et al., 2016). If drought conditions continue to become more frequent, lake levels will drop significantly during the next decades. The decrease in water levels implies changes in the quality of the water close to the intake for water supply, as these are commonly located within the top 18 m of water. Droughts are a worldwide concern for utility districts and water resource managers since low lake levels are generally linked to decreased water quality close to the intake, leading to substantial investment in the upgrade of treatment technology to maintain compliance with drinking water standards. Recent droughts have led to water quality implications for drinking water supplies including turbidity, taste and odor, pathogen concerns, and challenges in managing disinfection byproducts (DBPs) (Mishra et al., 2021; Mosley, 2015). Under these changing scenarios, stream-lake interactions will alter nutrient cycling, contaminant loading, and the quality of the water used for human consumption. Thus, accounting for the fate of stream inflows will be more critical for correctly predicting water quantity. Increasing air temperatures from climate change exacerbate atmospheric aridity, which leads to dry fuels that promote wildfires (Williams et al., 2019). The observed increase in wildfire activity in the North Coast and Sierra Nevada regions of California poses a threat to a lake's watershed. Wildfire effects on streams and lakes can have both short- and long-term impacts. During active burning, smoke and ash can be carried long distances and settle on streams, lakes, and reservoirs. After wildfires, erosion rates and nutrient runoff increase in burned areas. Impacts, during and after wildfires, potentially impact the quantity and quality of stream flow, altering the stream and stream-lake conditions of the water used for water supply for domestic, agricultural, and ecological purposes. Lake Tahoe has exhibited increasing frequency and magnitude of wildfires that can modify the properties of stream catchment areas. All these factors lead to changing scenarios that ultimately alter the water quality flowing into the lake and pose a threat to the current high water quality standards that characterize Lake Tahoe as a water resource.

Numerical models provide a predictive capacity to inform management actions under different scenarios including climate change, drought conditions, and wildfire-driven sediment and nutrient loading. Field studies and numerical modeling are powerful tools to quantify the fate and dilution of inflows into lakes. Field studies demonstrate the spatial and temporal variability of stream inflows and the lake's physical and chemical properties. Collected data are critical for the validation of numerical models. Numerical models, once updated and calibrated, can simulate the fate and dilution of stream-lake interactions and complement analysis from field deployments.

3.3. Main tasks

This proposal will:

(1) **Modify existing inflow algorithms** to better represent stream-lake interactions.
(2) Conduct **measurements** of the physical interactions between two streams (Ward and Incline Creeks) and the stratified Lake Tahoe to characterize the dilution and fate (spatial and vertical distribution) of the incoming stream plume.
(3) Incorporate the inflow algorithms into our **existing, public-domain, three-dimensional hydrodynamic model** and use the collected data to **calibrate and validate** the modified inflow algorithms.
(4) Use the validated model in combination with **nutrient and sediment loading scenarios** consistent with **wildfire effects** and quantify a range of potential management actions to improve water quality under effects induced by climate change.
(5) Use the validated model to explore the effects of **large drops in lake levels due to droughts** on the water quality at the intake of **water treatment plants** next to the study inflows (Tahoe City PUD and Incline Village GID). Model results will guide management actions during drought conditions.
(6) Convene 6-monthly technical workshops with all stakeholders to present on progress and to discuss any project course corrections that should be made.

For Lake Tahoe the management actions that will be explored for current and different inflow conditions induced by wildfires:

- The potential impact of stream nutrient loads on lake water quality in present conditions, and under scenarios of catchment areas altered by wildfires.
- The potential impact of low lake levels due to drought conditions on drinking water quality at the intake, and the recommended management actions when those conditions compromise the water resources for human consumption.
- The likelihood of maintaining Lake Tahoe's non-filtration exemption under scenarios of wildfire effects or drought conditions.
- The impact of future climate conditions on lake clarity.

3.4. Methods

3.4.1. Existing three-dimension hydrodynamic model: Si3D

The 3-D hydrodynamic model Si3D was originally developed by the US Geological Survey for simulating hydrodynamic and salinity conditions in the San Francisco Bay estuary (Smith 1997) and has been subject to continuous improvement and refinement by UC Davis since. It was based on the commercial TRIM model developed by Casulli and Cheng (1992). It was subsequently modified to better represent conditions in lakes and reservoirs and applied to Lake Tahoe, Clear Lake, and the Salton Sea (CA), as well as smaller lakes in the US and Europe (Acosta et al., 2015; Hoyer et al., 2014, 2015b, 2015a; Rueda & Cowen, 2005; Rueda & MacIntyre, 2009; Rueda & Schladow, 2003; Valbuena et al., 2022). The model has also been used to study underlying physical and biological interactions (Pasour & Ellner, 2010). It is currently being used to study complex upwelling dynamics in Lake Tahoe as described in (Valbuena et al., 2022), and the impacts of climate change on Northern Patagonian lakes (Swann, in submission).

The model can represent important physical processes including diel and seasonal stratification and mixing, linear and non-linear internal waves, and stream inflows; it is computationally efficient, both because of the underlying solver and its parallel architecture; it can nest fine grids at areas requiring high resolution (e.g. the littoral zone, river deltas); has a publicly accessible source code making it both transparent and amenable to future changes by others (https://github.com/SI3DL). A set of water quality modules for Si3D exists from the use of the model in the San Joaquin River (Doyle, 2010). The model will be run on a parallel cluster of computers available for the School of Engineering at UC Davis.

3.4.2. Algorithm development and model implementation

At the stream–lake interface, where these independently varying fluids come together, the external conditions of each water body will determine the degree of dilution that takes place. The dilution of the inflowing water occurs as a result of the entrainment of ambient water into the inflow. In this project, we will parameterize dilution in the model using different approaches (Cenedese & Adduce, 2010; Ellison & Turner, 1959; Fleenor, 2001), in addition to the standard equations already implemented in Si3D following Fischer et al. 1979. In addition, laboratory experiments suggest that currents not only entrain ambient water but also 'detrain' water before reaching the insertion depth (Baines, 2008). The Baines parameterization to quantify the entrainment-detrainment fluxes between density currents and the overlaying stratified water column will be implemented in Si3D for the first time. This could potentially affect the prediction of both the dilution and the fate of the inflow plume as it enters the lake.

3.4.3. Model calibration and validation with field observations

The collection of high-quality data will be essential for the calibration and validation of the improved 3D hydrodynamic lake model. The field experiments will focus on addressing the dynamics of the interaction between the stream and lake fluids. This interaction will change with stream flow rate, stream-lake density difference, lake stratification, and bathymetry. The degree of dilution will also impact the depth to which the inflow will plunge or flow over the lake's surface. Field tracer experiments will be conducted under different flow and stratification conditions using natural tracers such as the differences between stream and lake turbidity and conductivity. Additional data will be collected to support the interpretation of the experiment data, such as water currents, meteorological data, and drone imagery. We will conduct two experiments to capture different flow conditions (peak, and low) and lake stratification (ranging from weak to strong).

The two study sites are Ward Creek (CA) and Incline Creek (NV). For each stream, one period of measurement will be conducted in April-May, during the peak inflow from snowmelt and a developing lake stratification. The second will be conducted from July to mid-August, under low-inflow and maximum stratification conditions.

We will use an array of autonomous and manual equipment to monitor the stream and the lake during and after the natural tracer experiments (Fig. 3):

(1) A Stream in-situ Conductivity-temperature-depth (CTD) sensor will provide the initial conditions in the stream. It will also be equipped with a multi-channel fluorometer to measure turbidity, chlorophyll, and dissolved oxygen. Knowing each of these variables in the stream will enable us to calculate the dilution and track the fate of the plume. These are the variables that change throughout the day and provide the boundary conditions for the subsequent modeling of the stream dynamics in the lake. The stream flow rate is provided at 10-minute intervals by the USGS gauging station.

(2) A Wirewalker with an identical CTD will be deployed in the lake offshore from where the stream flows in. The Wirewalker is an autonomous profiling instrument that is powered by wave energy.

It will power itself down to the bottom of its "wire" every 20 minutes and then float up to the surface taking measurements at 6 Hz. At the top of the wire, the instrument offloads data via a cell modem, yielding near-real-time, high spatial resolution (<10 cm) profiles 3 times each hour, 24 hours a day. This will allow the continuous tracking of the intrusion of the inflow and the degree of dilution. As it operates continuously (day and night) and without human support, it can measure the impacts of the changing flow rates, stream temperature, and lake stratification with unparalleled fidelity. The Wirewalker will be deployed ahead of each measurement period and recovered when the experiment is complete (approx. 1-2 weeks).

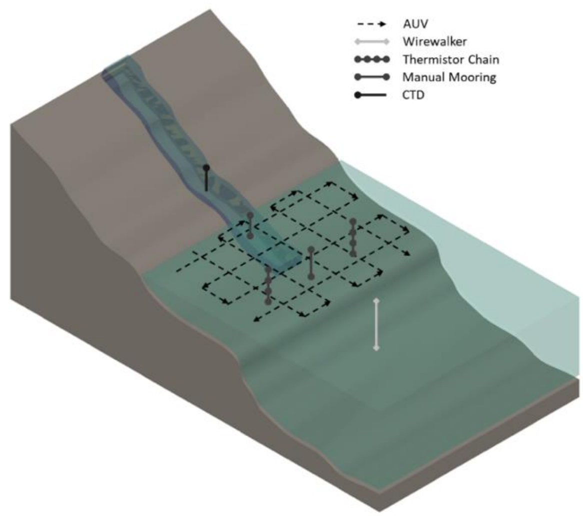

Fig. 3. General arrangement of instruments where the stream enters the lake

(3) Transects with an Autonomous Underwater Vehicle (AUV) equipped with a miniaturized CTD will provide data over a broad area where the stream enters the lake. Operating untethered at fixed heights above the lakebed, the AUV gathers high-resolution, water column data otherwise logistically difficult to collect with surface vessels or divers. The use of an AUV as a sampling platform will: (1) allow data validation in regions deeper than diver accessible (>40 m water depth); and (2) offer a potential cost-reduction over vessel surveys by being able to deploy from shore. The AUV travels up to speeds of 2.1 m/s and is equipped with a high precision depth sensor, an optical backscatter sensor, an upwards / downwards 1200 kHz acoustic Doppler current profiler (ADCP) or equivalent, and a SBE49 Conductivity-Temperature-Depth (CTD) logger as the primary scientific payload. The ADCP provided horizontal and vertical water velocities. The ADCP, depth, and CTD data will be used to determine and characterize the near- and far-field conditions of the stream inflows. With a battery duration of 3-4 hours, typical distances traveled are 20–30 km of survey that can be configured into parallel lines with a minimum separation of 2 m.

(4) Thermistor moorings. Two thermistor chains will also be deployed, with thermistors at fixed depths. These will provide high-frequency temperature measurements (8 Hz) at fixed depths through the water column. They will provide measurements of the internal wave field that drives many of the large-scale lake motions.

(5) Manual CTD profiles. CTD profiles will be measured during the experiments at multiple locations providing records of turbidity, chlorophyll, and dissolved oxygen, among others to complement the AUV sampling plan.

3.4.4. Wildfire effects scenario testing

Multiple nutrient and sediment loading scenarios will be analyzed using the numerical model Si3D, validated with the field observations. The different scenarios will represent the severity of wildfire effects on burned catchment areas. Using the open boundary capabilities of the numerical mode Si3D, wildfire effects on stream-lake interactions will focus on addressing water quality impacts in lake water and thus effects on drinking water from increased erosion and nutrient loading rates induced by wildfires. We will use nest fine grids at areas requiring high resolution (littoral zone).

3.4.5. Effects of low lake level due to drought conditions

We will use the validated model to explore the effects of large drops in the lake level due to drought conditions on the water quality at the intake of water treatment plans next to the study inflows (Tahoe City PUD and Incline Village GID). Under these changing scenarios, stream-lake interactions will change and potentially alter nutrient cycling, contaminant loading, and the quality of the water drawn from the lake for human consumption. Model results will guide management actions during drought conditions. A few of the critical management actions for responding to degraded water quality related to droughts include awareness of potential impacts, increased monitoring during and after the event, and capacity to quickly adjust water treatment processes.

3.5. References

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4. Evaluation Criteria

A. Water Management Challenge (30 points)

- *Describe the water management challenges.*

This project aims to tackle the water management challenges arising from **climate-change-induced wildfires and droughts** in lakes, compounded by the **limited understanding of the dynamics of stream fate and dilution into lakes and reservoirs**, both spatially and temporally. Wildfires have the potential to elevate the influx of nutrients, contaminants, and fine sediments washed into lakes and reservoirs from the watershed, thereby **affecting the water quality** in these systems. Drought events may lead to substantial declines in water levels, which can have adverse effects on water quality at fixed water intakes. Increased extreme flows will exacerbate streambed erosion and thereby increase sediment loads.

In the context of Lake Tahoe, water clarity serves as a critical indicator of the presence of particulates, contaminants, and nutrients in the water column. Since all drinking water intakes are situated within the upper 20-30m, extreme events such as wildfires and droughts can significantly impact the quality of lake water extracted for drinking purposes and the overall ecological health of the ecosystem.

- *Describe the concerns or outcomes if this water management challenge is not addressed.*

Inflowing streams represent the primary source for delivering nutrients, particulates, contaminants, and water of a specific temperature to lakes and reservoirs. The extent of their dilution and depth of insertion can have ecological and water quality consequences. Ecologically, for example, in some systems such as Shasta Reservoir, it is critical to retain a cold-water pool to have a reserve for release during salmon spawning seasons. In Lake Tahoe, the insertion of nutrients and fine particles impacts algal blooms and lake clarity. While managers may not have strategies for controlling the inflows, having the predictive ability to know how the lake profile will evolve under a range of inflow scenarios allows managers to plan operations to minimize risks. With the extreme events of climate change, this is more critical as input loads may reach unprecedented levels. Linked to this is the increasing occurrence of harmful algal blooms (HABs) which may be better managed by planning for the selective withdrawal of layers of high-nutrient water. This is most possible with foreknowledge of where inflows will be inserted.

Extreme **droughts** will lower water levels which will provide water purveyors who have fixed depth intakes with a greatly altered raw water quality. Similar concerns exist for reservoirs with fixed penstock depths. Without an accurate predictive tool of the fate of inflow water, **management planning will be highly constrained.**

Current management strategies were not formulated to address the massive scale of **wildfires** occurring in the West. Without a better model representation of the fate of the vastly increased loads (and higher flows) from burned and denuded watersheds, managers are at risk for the development of inaccurate predictions for water management actions following wildfire events.

- *Explain how your project will address the water management issues identified in your responses.*

Accurate predictions of stream-lake interactions and the resulting water quality at extraction points are invaluable for allowing the pre-planning of management responses for normal operations and reactions to wildfires and droughts. A more robust understanding of the factors governing stream fate and dilution enables us to assess how wildfires and drought conditions affect these crucial processes. This empowers lake managers with advanced insights into anticipated changes and allows for prioritization of watershed mitigation projects.

This project proposes the **enhancement of existing numerical tools** to effectively characterize the intricate dynamics of stream-lake interactions. Its ultimate goal is to assess the deterioration of water quality in lakes and reservoirs caused by the anticipated large changes that will be induced by climate change, including wildfires and droughts.

B. Project Benefits (30 points)

- *Describe how the need for the project was identified.*

Despite decades of research, there remains a considerable gap in our understanding of the fate and dilution of stream inflows when they enter lakes. This knowledge gap arises partly from the highly transient nature of the physical properties of inflows and the receiving lake water. The challenge is compounded by the anticipation of major changes to the governing factors of stream-lake interactions due to **climate change** and the associated changes in wildfire frequency and intensity, and in the frequency and intensity of droughts. Recognizing these challenges, the Incline Village General Improvement District and Tahoe Water Suppliers Association (TWSA) have collaborated with our research team to develop this project concept. Their concerns relate to the **challenges of ensuring high water quality** with fixed intake depths when the vertical distribution of water quality factors such as high sediment concentrations, HABs, and other contaminants are likely to change considerably in the future. Our project team has experience working on other systems where the vertical distribution of temperature (also governed by stream-lake interactions) is a critical management concern (e.g., Shasta Reservoir, Lake Powell).

- *Describe how the tool, method, or information will be applied and when will it be applied.*

The overarching objective of this project is to create an **improved modeling tool** that will empower us to comprehensively assess the **anticipated alterations in lake water quality**. These transformations are expected to result from the significant influence of extreme events such as **wildfires and droughts** on the fate of streamflow as it enters the lake. The project's ultimate aim is to deliver precise forecasts of future conditions, thereby equipping water stakeholders, management authorities, tribal communities, and relevant organizations with the essential data needed to formulate robust water management plans for in-lake water quality conditions under future climate conditions (including **Drought and Wildfire Action Plans**) for which managers currently have very limited experience and precedent to draw upon.

- *Describe, in detail, the extent of benefits that can be expected to occur upon implementation of the project and provide support for your responses.*

This proposal is centered on the development of **predictive models** crucial for the formulation of comprehensive **future strategies** based on the acquisition of high-resolution temporal and spatial data gathered through autonomous systems to properly validate the improved model. The execution of this project will necessitate the active involvement of a broad spectrum of stakeholders, including water users, state agencies in Nevada and California, federal government bodies, and indigenous tribal communities. A Project Advisory Committee formed by the different stakeholders will provide the project team with a broad range of perspectives during technical workshops on the detailed design of the experiments and the model outputs to ensure that the outputs of the model provide what all stakeholders need.

The new inflow algorithm will be incorporated into a **public domain**, a three-dimensional hydrodynamic model that will be freely available. The source code for the inflow algorithm will also be freely available for those agencies that may wish to insert it into the existing hydrodynamic models.

The ability to **forecast** interactions between streams and lakes, as well as predict the time-varying **water quality** distribution three-dimensionally throughout the lake and especially at water intake points will allow for effective management interventions during a broad range of future conditions. Managers can use such a model in a predictive manner to explore ranges of future conditions and plan future management strategies. This capability will significantly enhance the **responsiveness and decision-making** of all involved parties.

- *Explain how your project complements other similar efforts in the area where the project is located.*

Forecasting the clarity of Lake Tahoe is a paramount issue for local, State, and Federal Agencies. To this end, the one-dimensional Lake Tahoe Clarity Model was developed in 2001 to support the formation of a Total Maximum Daily Load (TMDL). More recently the same agencies funded the production of a three-dimensional version of this model (Tahoe Science Advisory Council Report, 2022). However, the funding available only allowed a focus on the deep-water processes, and the stream-lake interactions were only modeled based on the poor understanding that existed. This project will allow the development of a better understanding of the three-dimensional stream-lake interactions through our novel capability of using high-speed, autonomous sampling to capture the rapid spatial and temporal variability. These data will be used to develop the improved inflow algorithm and to calibrate/validate the model. Future climate scenarios will be developed using recently developed hydrologic inputs for a range of climate change scenarios (Dettinger 2013). This report will also complement earlier modeling studies on behalf of IVGID and other water suppliers at Lake Tahoe, where the issue of entrainment of pathogens into drinking water intakes was the issue being addressed. This earlier study relied on highly over-simplified inflow algorithms.

C. Project Implementation (20 points)

- *Briefly describe and provide support for the approach and methodology that will be used to meet the objectives of the project.*

This project entails a **refinement of the inflow algorithms within an existing hydrodynamic model**, aimed at enhancing the representation of stream-lake interactions. To accomplish this, we will embark on the calibration and validation of these revised equations, requiring a distinctive dataset. Our approach involves **comprehensive field measurements** of the dynamic interactions between two significant streams, Ward and Incline Creeks, and the stratified Lake Tahoe. This data will allow us to comprehensively characterize aspects such as stream dilution and the trajectory of inflowing water, including its constituent components such as nutrients, contaminants, particles, and sediments. By examining these two distinct inflow sources, we can account for variations in the interactions between the lake and streams originating from contrasting terrains. Ward Creek, with its steep basin, stands in contrast to Incline Creek, which flows from a moderately sloped basin and is also near a water intake vital for the water supply managed by IVGID.

Once these numerical models are updated and calibrated/validated, they will serve as powerful tools to simulate the complex transport and dilution dynamics associated with stream-lake interactions. Moreover, these models will provide valuable **predictive capabilities**, enabling us to proactively inform and guide management decisions across a range of scenarios, including those influenced by **climate change**, drought conditions, and the influx of sediment and nutrients driven by wildfires.

- *Describe the work plan for implementing the proposed scope of work (project schedule, milestones with dates)*

This project schedule with key activities and deliverables is described in the following Table:

		2024	**2025**				**2026**
Key Activities	**Key Deliverables**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**
Purchase of equipment		■	■				
	Initial technical workshop with stakeholders		■				
Literature review and modification of inflow algorithms in the model		■	■				
Spring field work at two Creeks				■			
Late summer field work at two Creeks					■		
	Technical workshop with stakeholders				■		
Calibrate and validate the modified inflow algorithms in the model					■	■	
Preparation of field and modeling reports				■	■	■	
	Final technical workshop with stakeholders						■
	Submission of Field and Modeling Reports						■

- *Provide a summary description of the products that are anticipated to result from the project (data, reports, publications).*
  - Data reports on each set of measurements for Ward Creek and Incline Creek at Lake Tahoe. The data itself will be stored on an online public repository.
  - Report on the model calibration and validation for each stream.
  - Model report on the management scenarios described above (wildfires and drought conditions) under the range of future climate conditions.
  - Convene 6-monthly technical workshops with all stakeholders (Project Advisory Committee) to present on progress and to discuss any project course corrections that should be made (e.g., model outputs, problems to consider under future climate scenarios).
  - Establish data repositories for future access.

- *Who will be involved in the project as project partners? What would be their role? How would they be engaged? If you are a Category B applicant, be sure to explain how your Category A partner will be engaged in the project.*

In this proposal, we are pleased to have the Incline Village General Improvement District (IVGID) as our dedicated partner. IVGID plays a pivotal role within the Tahoe Water Suppliers Association (TWSA), representing the collective interests of all water purveyors operating within the Lake Tahoe region. Their invaluable input and partnership have been instrumental in shaping the core concept of this proposal.

Throughout the project's lifecycle, IVGID will continue to serve as a key ally, offering essential support in various capacities. Notably, they will act as the primary conduit for disseminating our research findings to the public, ensuring that our results are effectively communicated to the broader community. Additionally, IVGID will provide invaluable on-the-ground expertise and guidance as part of the Project Advisory Committee, further enhancing the project's overall success and impact. Their active involvement underscores the cooperative spirit of this initiative and strengthens our collective commitment to advancing our understanding of Lake Tahoe's water quality.

- *Identify project staff members with appropriate credentials and experience for this project. Describe the process and criteria to select project staff members that have not yet been filled.*

Dr. Alicia Cortés (PI) is a Project Scientist at UC Davis whose training focuses on the coupling of physical and biogeochemical processes in aquatic ecosystems. She uses field observations and numerical models to improve our understanding and predictions of how inland water bodies will behave under future climate scenarios. Her Ph.D. focused on characterizing the inflow dynamics in Mediterranean reservoirs and laboratory studies. Dr. Sergio Valbuena (co-PI) is a Project Scientist at UC Davis trained in the area of physical limnology (using both field observations and numerical models). He also worked at Lake Tahoe during the last 5 years, hence, he is very familiar with the system. Dr. Alex Forrest (co-PI) is a Professor at UC Davis who specializes in the use of robotics and autonomous vehicles in the field of physical limnology. Dr. Geoffrey Schladow is an Emeritus Professor at UC Davis and the previous Director of the Tahoe Environmental Research Center (TERC) with experience in all the above subjects and will provide technical advice in this project as a member of the Project Advisory Committee. He also has a very wide network of contacts in the Tahoe Basin, which will be very beneficial to disseminate the results of this project. One of the Staff Research Associates from TERC will participate in the field activities and provide boat assistance. We will hire a Postdoctoral Scholar with field and modeling skills in physical limnology to execute field work and further explore wildfires and drought scenarios.

D. Dissemination of Results (10 points)

- *Describe how the tools, frameworks, or analyses developed will be disseminated, communicated, or made available to water resources managers. Also, describe how project results will be communicated to project partners.*

The communication strategy between UC Davis and our project partner/stakeholders will involve two key approaches. Firstly, we will host three technical workshops at the inception, after 6 months, and after the project. These meetings will facilitate continuous progress reporting and the exchange of insights with the **Project Advisory Committee**, ensuring that partner's and stakeholder's input is consistently incorporated into the project's direction. Secondly, TERC's outreach program will support the development of education products to elucidate our project objectives, timeline, and share our findings with a wider audience. As part of our outreach program, we are planning to participate in the Tahoe Federal Summit and the Tahoe Science Advisory Council (TSAC) science conferences.

As part of our commitment to transparency and collaboration, UC Davis will extend invitations to various organizations to participate in our **outreach events**. This inclusive approach will engage stakeholders such as the Tahoe Water Suppliers Association, the Tahoe Science Advisory Council, the Tahoe Regional Planning Agency, the Lahontan Regional Water Quality Control Board, the Nevada Division of Environmental Protection, the Washoe Tribal Council, and other local entities. All of them are welcome to participate as a member of the Project Advisory Committee. Their participation will not only enhance the dissemination of project outcomes but also foster a collective effort to address water quality issues in the Lake Tahoe region.

E. Presidential and Department of Interior Priorities (10 points)

The impetus behind this proposal lies in the imperative to assess and analyze strategies and alternatives for the management of lakes, with a particular focus on safeguarding the provision of high-quality water resources and preserving the natural environment. Lakes and reservoirs are a critical part of the nation's infrastructure and ensuring the delivery of the highest quality drinking water and protecting sensitive environments and ecosystems are of utmost importance. This initiative is driven by a proactive response to the challenges posed by **climate change**, including the heightened risks associated with events such as wildfires and prolonged drought conditions. Our objective is to develop effective solutions that can adapt to these evolving environmental scenarios, ensuring the sustainable management of lakes, the continuity of pristine water supply, and the protection of ecosystems.

5. Project Budget

5.1. Budget Proposal

University of California, Davis (UC Davis) will conduct the project elements described above. IVGID will act in partnership and agree to the submittal and content of the application.

A summary of the budget proposal is presented in Tables 1, 2 and 3.

Table 1*. Total Project Cost Table*

Funding Sources	Amount
Costs to be reimbursed with the requested Federal funding	$ 400,000
Costs to be paid by the applicant	$ 147,077
Value of third-party contributions	$ -
TOTAL project cost	**$ 547,077**

Table 2*. Summary of Non-Federal and Federal Funding Sources*

Funding Sources	Amount
Non-Federal entities	
Incline Village General Improvement District (IVGID)	$ -
University of California, Davis (UC Davis)	$ 400,000
Non-Federal subtotal	$ 400,000
REQUESTED Reclamation funding	**$ 400,000**

Table 3*. Summary of the budget costs per category*

Summary			
6. Budget Object Category	**Total Cost**	**Federal Estimated Amount**	**Non-Federal Estimated Amount**
a. Personnel	**$158,194**		
b. Fringe Benefits	**$51,814**		
c. Travel	**$3,919**		
d. Equipment	**$100,000**		
e. Supplies	**$50,800**		
f. Contractual	**$0**		
g. Construction	**$0**		
h. Other Direct Costs	**$12,960**		
i. Total Direct Costs	**$377,688**		
i. Indirect Charges	**$169,389**		
Total Costs	**$547,077**	**$400,000**	**$147,077**
	Cost Share Percentage	**73%**	**27%**

5.2. Budget Narrative

A. PERSONNEL

The labor rates included in the budget proposal represent the actual labor rates of the identified personnel/positions and are consistently applied to Federal and non-Federal activities. Pursuant to University of California (UC) policy, salaries in the initial budget period are based on current published UC salary scales and include University mandated range adjustments and merit increases scheduled to occur before the proposed project start date. Pay rate increases in subsequent years are based on merit review schedules established by UCD Academic Affairs and Human Resources. Annual salary is escalated 3%.

<u>Alicia Cortes, Project Scientist, Principal Investigator</u>
Year 1 effort: October 1, 2024 - September 30, 2025, 26%
Year 2 effort: October 1, 2025 - March 31, 2026, 26%
Dr Alicia Cortés will be the PI for UC Davis. She will oversee the project and lead lake sampling efforts. She will be responsible for communicating with the Incline Village General Improvement District (IVGID), and Tahoe Basin Agencies. She will be responsible for the day-to-day project management, and the stream inflow algorithms. She will also actively participate in publication efforts to disseminate project findings. She will be primarily responsible for supervising and mentoring the postdoctoral scholar.

<u>Sergio Valbuena, Postdoctoral Scholar, co-Principal Investigator</u>
Year 1 effort: October 1, 2024 - September 30, 2025, 26%
Year 2 effort: October 1, 2025 - March 31, 2026, 26%
Dr. Sergio Valbuena will be a co-Principal Investigator for this project. He will be responsible for the numerical modeling aspects for both Lake Tahoe. He will be also responsible for field sampling efforts, the analysis of Wirewalker data, and thermistor chain data. PI Valbuena will assist with overseeing the project objectives and actively participate in publication efforts. He will assist with directing the work of the Staff Research Associate and Postdoctoral Scholar.

<u>Alex Forrest, Associate Professor, co-Principal Investigator</u>
Year 1 effort: October 1, 2024 - September 30, 2025, 6%
Dr. Alex Forrest will be a co-Principal Investigator for this project. Dr. Forrest has unique expertise in the operation of Autonomous Underwater Vehicles and will act as the primary pilot. He will also be responsible for the analysis of AUV data.

<u>To Be Named, Postdoctoral Scholar</u>
Year 1 effort: October 1, 2024 - September 30, 2025, 50%
Year 2 effort: October 1, 2025 - March 31, 2026, 50%
The postdoc will assist with executing the research tasks as described in the project narrative by participating in lake profiling and sampling efforts. This person will have responsibility for conducting the fieldwork and the data analysis. This person will work in conjunction with PIs Cortés, Valbuena, and Forrest.

<u>*(COST SHARE)* To Be Named, Staff Research Associate</u>
Year 1 effort: October 1, 2024 - September 30, 2025, 8%
The SRA will assist with sampling, research vessel operation, and instrument deployment (thermistor chains, AUV, CTD, and wirewalker). This staff member will provide technical support for the conduct of

all field operations, including installation and removal of equipment, servicing of equipment, and maintaining and repairing equipment as necessary.

B. FRINGE BENEFITS

Fringe benefits are assessed as a percentage of the respective employee's salary and are calculated using the UC Davis composite rates developed by the UC Davis Costing and Policy and approved in the federally negotiated rate agreement dated June 28, 2021. Fringe benefits for employees escalate by 3% each fiscal year, July 1st – June 30th, based on campus budget projections and consistent with guidance from the University of California, Davis (UCD) Costing Policy and Analysis office. These benefits include health and life insurance, social security, Medicare, dental plan, vision, unemployment insurance, non-industrial disability insurance, worker's compensation insurance, and retirement. Fringe benefit rates are calculated as follows:

<u>Cortes and Valbuena: Fringe benefit rate used is Faculty, Acad, MSP, and Safety.</u>
Year 1
Approved rate from 10/01/2024 - 06/30/2025 (9 months): 40.8%.
Approved rate from 07/01/2025 - 09/30/2025 (3 months): 42%
Year 2
Approved rate from 10/01/2025 - 03/31/2026: 42%

<u>Forrest: Fringe benefit rate used is Faculty Summer - C</u>
Year 1
Approved rate from 10/01/2024 - 06/30/2025 (9 months): 9.4%.
Approved rate from 07/01/2025 - 09/30/2025 (3 months): 9.4%

<u>To Be Named Postdoctoral Scholar: Fringe benefit rate used is Postdoc Employees.</u>
Year 1
Approved rate from 10/01/2024 - 06/30/2025 (9 months): 22.8%.
Approved rate from 07/01/2025 - 09/30/2025 (3 months): 23.5%.
Year 2
Approved rate from 10/01/2025 - 03/31/2026: 23.5%

<u>*(COST SHARE):* Staff Research Associate: Fringe benefit rate used is All Other Staff</u>
Year 1
Approved rate from 10/01/2024 - 06/30/2025 (9 months): 53.1%.
Approved rate from 07/01/2025 - 09/30/2025 (3 months): 54.7%.

C. TRAVEL

Two fieldwork trips are planned, one in the spring and one in the fall. Two project personnel will travel from Davis, CA to field sites in the Lake Tahoe area for seven-day research trips. Lodging is planned at the Tahoe Environmental Research Center scholar housing located in Tahoe City, CA at a current rate of $29/night per traveler. A 1/2 ton truck will also be rented from UC Davis Fleet Services at a current rate of $64/day. Meals and incidentals are budgeted at the currently approved rate of $79/day.

D. EQUIPMENT

(COST SHARE): A Wirewalker (including a Conductivity-Temperature-Depth (CTD) profiler equipped with the auxiliary sensors) will be purchased for this project. This instrument profiles the water column

continually and provides a complete profile at approximately 20-minute intervals (10 cm vertical spatial resolution). Due to the rapidly changing conditions during stream inflow, this level of resolution is essential. Vendors do not offer short-term rentals for the wirewalker. ($100,000)

E. SUPPLIES

Funds are requested to purchase supplies and materials as follows to meet the project objectives as described in the proposal:

- Public outreach materials and supplies - $2,500: Project-specific outreach material to distribute to stakeholders.
- Safety supplies - $2,000: Safety supplies needed to ensure safe handling and transport of equipment.
- Fieldwork data collection consumables - $3,000: Consumable supplies needed for fieldwork sample collection.
- Computer cluster nodes - $5,000: Server nodes needed for data storage.
- Software licenses and user fees - $2,500: Licenses for data processing software
- College of Engineering IT support - $4,000: Fee to support network infrastructure for data processing.
- Data satellite changes - $2,000: Data transfer from equipment to network via satellite. Proposed Vendor: Woods Hole.
- Computer peripherals and hard drives - $1,500: Project specific peripherals to secure data collection
- Project-specific computers - $3,000: Project-specific laptop to be used for data collection, storage, and management.
- Parts and tools for moorings - $4,000: Supplies needed to build moorings. Proposed Vendor: RBR.
- AUV supplies, maintenance, and calibration - $4,000: Cost from the vendor (Teledyne) to perform annual maintenance on the AUV system.
- Parts and tools for thermistor chain assembly - $5,000: Thermistor chain to be purchased to meet the scope of work as outlined in the narrative. Proposed Vendor: RBR.
- Weather Station network repair and maintenance - $2,000: Supplies to perform routine maintenance on weather station sites.
- *(COST SHARE)* Amazon Web Server - $6,300: Server needs to collect and store project data. Calculated at a monthly cost of $350/mo for duration of project.
- *(COST SHARE)* Project-specific laptop and peripherals - $4,000: Project-specific laptop to be used for data collection, storage, and management.

Basis of costs from previous projects or vendor catalogs available in AggieBuy, the UCD procurement marketplace. AggieBuy prices reflect negotiated systemwide contracts.

F. CONTRACTUAL

Not applicable to this proposal.

G. CONSTRUCTION

Not applicable to this proposal.

H. OTHER DIRECT COSTS

$3000 in funding is requested to assist with project result dissemination in an open-access journal. This amount is based on current publication prices for major peer-reviewed journals in the project’s topical area.

(COST SHARE): $1,500 in funding is committed to assist with project result dissemination in an open-access journal. This amount is based on current publication prices for major peer-reviewed journals in the project's topical area.

(COST SHARE): The Tahoe Environmental Research Center commits 60 hours of research vessel use to this project. The amount of this contribution is based on the current recharge rate of $141/hr.

J. INDIRECT COSTS

UCD's indirect costs are calculated based on Modified Total Direct Costs (MTDC) as defined in 2 CFR Part 200.68 using facilities and administration (F&A) rates approved by the U.S. Department of Health and Human Services (DHHS). For this project, MTDC is comprised of total direct costs less capital equipment. This project will be located On-Campus. Based on UCD's F&A rate agreement dated 06/28/2021, indirect costs for this project are calculated at an approved rate of 61% for the period of 10/01/2024 – 06/30/2025 and a provisional rate of 61% for the period of 07/01/2025 – 03/31/2026.

6. Environmental and Cultural Resources Compliance

For Lake Tahoe, the nature of the work being conducted does not present threats to environmental or cultural resources. However, UC Davis will obtain the concurrence of the Tahoe Regional Planning Agency, the Lahontan Regional Water Quality Control Board, and the Nevada Division of Environmental Protection before any work commences. The Contractor will also seek the concurrence of the Washoe Tribal Council. If environmental or cultural threats are identified by any of these groups, UC Davis will work with them to alleviate such threats and be fully compliant.

7. Required Permits or Approvals

No approvals or permits are required for the field work at Lake Tahoe. The equipment to be deployed is short-term, creates no disturbance to the lake bottom, and has no emissions.

8. Overlap or Duplication of Effort Statement

We confirm that there is no overlap between the proposed project outlined in this application and any other active or anticipated proposals. The activities, costs, and commitment of key personnel associated with this project are distinct and unique from any other ongoing or planned initiatives. Our team is fully dedicated to the successful execution of this project and will not be concurrently engaged in any other efforts that could create a conflict of interest or resource allocation issues. We are committed to the successful completion of this project and ensuring that it remains separate from any other activities.

9. Letters of Support

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO   SANTA BARBARA • SANTA CRUZ

BREN SCHOOL OF ENVIRONMENTAL SCIENCE & MANAGEMENT
JOHN MELACK, PROFESSOR

SANTA BARBARA, CA 93106
http://www.bren.ucsb.edu/

11 October 2023

Dear Dr. Cortés and Dr. Valbuena,

I confirm my support of the UC Davis proposal to the USBR WaterSMART Applied Science Grant program titled, "*Modeling the impacts of stream inflows on water quality under a changing climate*".

I understand that the main focus of the proposed research is the development of an improved modeling tool to allow for the evaluation of changes in lake water quality due to stream-lake interactions. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in streamwater, and lower lake levels. The results of this project will be of great value to Lake Tahoe and to other lakes and reservoirs.

I would be prepared to serve on a community advisory group to help provide input on project planning, objectives and outputs.

Sincerely,

Professor
Co-chair, Tahoe Science Advisory Council

PHONE: (805) 893-3879 •EMAIL MELACK@BREN.UCSB.EDU • FAX: (805) 893-7612

TAHOE REGIONAL PLANNING AGENCY

Mail
PO Box 5310
Stateline, NV 89449-5310

Location
128 Market Street
Stateline, NV 89449

Contact
Phone: 775-588-4547
Fax: 775-588-4527
www.trpa.gov

October 13, 2023

Dr. Alicia Cortés and Sergio Valbuena
University of California, Davis
One Shields Ave s Davis s CA 95616

Dear Dr. Cortés and Dr. Valbuena,

The Tahoe Regional Planning Agency (TRPA) leads the collaborative effort to preserve, restore, and enhance the unique natural and human environment of the Lake Tahoe Region, while improving local communities, and people's interactions with our irreplaceable environment. On behalf of the TRPA, I am pleased to offer our support of the UC Davis proposal to the USBR WaterSMART Applied Science Grant program titled, "Modeling the impacts of stream inflows on water quality under a changing climate".

We understand that the main focus of the proposed research is the development of an improved modeling tool to allow for the evaluation of changes in lake water quality due to stream-lake interactions. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in streamwater, and extreme lower lake levels. We believe that the results of this project will be of great value to Lake Tahoe and to other lakes and reservoirs.

The multi-stakeholder partnership working to restore Lake Tahoe relies on science like this to build Tahoe's resilience in these changing times. Aside from the multi-billion-dollar annual economy that a healthy lake supports, Lake Tahoe is an iconic lake that draws attention nationally. The innovations that are pioneered at Tahoe are adopted and enhanced elsewhere. The Tahoe Regional Planning Agency supports the funding for a new highspeed electric research vessel for the UC Davis Tahoe Environmental Research Center (TERC).

We would also be pleased to serve on a community advisory group to help provide input on project planning, objectives and outputs could be better tailored to meet the objectives and needs of the TRPA and the boarder Tahoe region partnership.

Sincerely,

Dan Segan

Chief Science and Policy Advisor
Tahoe Regional Planning Agency

United States Department of the Interior

BUREAU OF RECLAMATION
Lahontan Basin Area Office
705 North Plaza Street, Room 320
Carson City, NV 89701-4015

IN REPLY REFER TO:

Oct 12, 2023

LO-900
2.2.3.18

VIA ELECTRONIC MAIL

Dr. Alicia Cortés and Dr. Sergio Alejandro Valbuena
Tahoe Environmental Research Center
University of California, Davis
One Shields Avenue
Davis, California 95616
alicortes@ucdavis.edu
savalbuena@ucdavis.edu

Subject: Support for UC Davis WaterSMART Applied Science Grant Proposal

Dear Dr. Cortés and Dr. Valbuena:

On behalf of the Bureau of Reclamation (Reclamation) I wish to confirm our support of the UC Davis proposal to Reclamation's WaterSMART Applied Science Grant program titled, *"Modeling the impacts of stream inflows on water quality under a changing climate."*

We understand that the main focus of the proposed research is the development of an improved modeling tool to allow for the evaluation of changes in lake water quality due to stream-lake interactions. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in streamwater, and extreme lower lake levels. We believe that the results of this project will be of great value to Lake Tahoe and to other lakes and reservoirs.

We would be prepared to serve on a community advisory group to help provide input on how the project planning, objectives and outputs could be better tailored to meet the objectives and needs of Reclamation.

Please contact me at (775) 884-8358 or dlahde@usbr.gov. If you are deaf, hard of hearing or have a speech disability, please dial 7-1-1 to access telecommunications relay services.

Sincerely,

DANIEL LAHDE Digitally signed by DANIEL LAHDE
Date: 2023.10.12 11:32:51 -07'00'

Dan Lahde
Special Studies Division Manager

NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION

STATE OF NEVADA
Department of Conservation & Natural Resources
Joe Lombardo, *Governor*
James A. Settelmeyer, *Director*
Jennifer L. Carr, *Administrator*

10/13/2023

Dr. Cortés and Dr. Valbuena
University of California, Davis
One Shields Ave
Davis, CA 95616

RE: SUPPORT LETTER FOR GRANT APPLICATION

Dear Dr. Cortés and Dr. Valbuena,

On behalf of the Nevada Division of Environmental Protection (NDEP), I wish to confirm our support of the UC Davis proposal to the US Bureau of Reclamation's WaterSMART Applied Science Grant program titled, "*Modeling the impacts of stream inflows on water quality under a changing climate"*.

We understand that the focus of the proposed research is the development of an **improved modeling tool** to allow for the evaluation of changes in lake water quality due to stream-lake interactions. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in streamwater, and extreme lower lake levels. This information is foundational to being better able to respond and adapt to a changing climate. We believe that the results of this project will be of great value to Lake Tahoe and to other lakes and reservoirs.

We would be prepared to serve on a community advisory group to help provide input on how the project planning, objectives and outputs could be better tailored to meet the objectives and needs of NDEP.

Sincerely,

Jason Kuchnicki

Jason Kuchnicki
Chief, Bureau of Water Quality Planning

ec: Dr. Danilo Dragoni
Deputy Administrator
Nevada Division of Environmental Protection

901 S. Stewart Street, Suite 4001 • Carson City, Nevada 89701 • p: 775.687.4670 • f: 775.687.5856 • ndep.nv.gov

CALIFORNIA
Water Boards

GAVIN NEWSOM
GOVERNOR

YANA GARCIA
SECRETARY FOR
ENVIRONMENTAL PROTECTION

Lahontan Regional Water Quality Control Board

October 11, 2023

Dr. Cortés and Dr. Valbuena
University of California, Davis
TERC Laboratories and Offices | Tahoe Science Center
Tahoe Center for Environmental Sciences
291 Country Club Dr.
Incline Village, NV 89451

UC Davis proposal to the USBR WaterSMART Applied Science Grant program titled, "Modeling the impacts of stream inflows on water quality under a changing climate"

On behalf of the Lahontan Water Quality Control Board (Lahontan Water Board) I wish to confirm our support of the UC Davis proposal to the USBR WaterSMART Applied Science Grant program titled, "Modeling the impacts of stream inflows on water quality under a changing climate".

We understand that the main focus of the proposed research is the development of an improved modeling tool to allow for the evaluation of changes in lake water quality due to stream-lake interactions. The types of future conditions envisaged include climate-altered hydrology, earlier lake warming, wildfire contaminants in streamwater, and extreme lower lake levels. We believe that the results of this project will be of great value to Lake Tahoe and to other lakes and reservoirs. This work will contribute to the new Lake Tahoe 3-D model, which will be very valuable to our work related to Lake Tahoe's water quality.

As resources allow, we look forward to serving on an advisory group to help provide input on how the project planning, objectives and outputs could be better tailored to meet the objectives and needs of Lahontan Water Board. If you wish to further discuss this letter, please contact me at (530) 542-5400 and melissa.thaw@waterboards.ca.gov.

Melissa Thaw

Melissa Thaw, PhD
Environmental Scientist
Non-Point Source Unit

10. Letter of Partnership

INCLINE VILLAGE
GENERAL IMPROVEMENT DISTRICT

October 16th, 2023

US Bureau of Reclamation
Ms. Stephanie Micek
Phone: 406-247-7320

Re: Funding Opportunity No. R23AS00446 - "Modeling the impacts of stream inflows on water quality under a changing climate"

Dear Ms. Stephanie Micek:

I am writing on behalf of the Incline Village General Improvement District, IVGID (Category A) to confirm our partnership with the applicant University of California Davis, UCD (Category B) on the WaterSMART Applied Science Grant application titled "*Modeling the impacts of stream inflows on water quality under a changing climate*".

IVGID plays a pivotal role within the Tahoe Water Suppliers Association (TWSA), representing the collective interests of all water purveyors operating within the Lake Tahoe region. We understand that the main deliverable of the proposed project is an enhanced computer model for predicting the impact of stream inflows on water withdrawn from the lake for domestic use. The results of this project, if funded, will have a lot of utility for IVGID and the TWSA member agencies. We agree to act in partnership with the applicant (UCD), as well as the submittal and content of the application.

IVGID's main roles will be to serve on a project advisory group to provide input on how the project planning, objectives and outputs could be better tailored to meet the objectives and needs of our own organization and other water suppliers in the Tahoe basin. We will help disseminate the applicant's research findings to other water agencies to the public. Our active involvement underscores the cooperative spirit of this initiative and strengthens our collective commitment to advancing our understanding of Lake Tahoe's water quality.

We advocate the importance of promoting this project to benefit Lake Tahoe's water quality, which is expected to change in the future due to combinations of climate change impacts on streams and the lake, wildfires, and extremes in lake levels.

Sincerely,

Madonna Dunbar
Resource Conservationist, Public Works, Incline Village General Improvement District
Executive Director, Tahoe Water Suppliers Association
1220 Sweetwater Rd, Incline Village NV 89451
Phone: 775-832-1284 / email: mod@ivgid.org