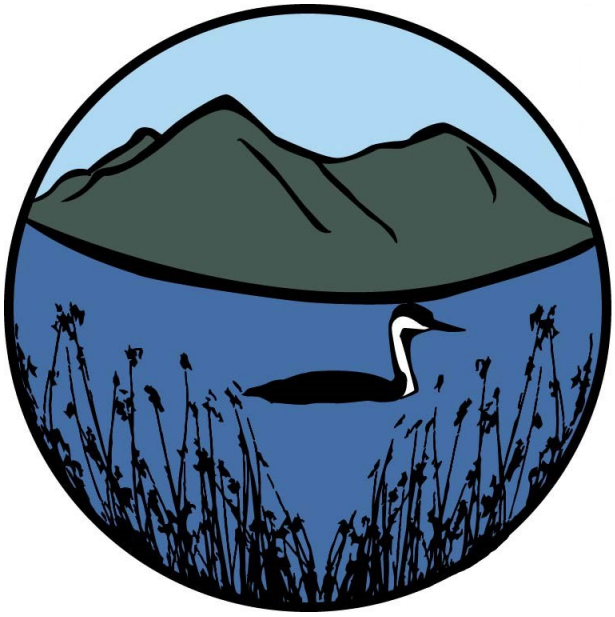

Blue Ribbon Committee for the Rehabilitation of Clear Lake

2023 Project Proposals for Committee Consideration

May 6, 2023

Contents

EutroPhix: Improving Restoration Efforts at Clear Lake with In-Lake Management of Phosphorus

Proposal Date: May 5th , 2023

Project Description:

Summary: Clear Lake is a culturally and economically important resource to the area and its people. Decades of research has occurred to increase the limnological understanding, identify ecosystem stressors, implement a nutrient TMDL and watershed management activities. The key drivers of poor water quality are watershed loading of sediment and nutrients, internal nutrient loading, and dominance of toxic cyanobacteria. The prolific harmful algae blooms (HABs) on Clear Lake are some of the worst in the United States and has deteriorated ecosystem services provided and limited economic opportunity and growth of the local economy for decades. While there has been a nutrient TMDL process being implemented to control external inputs and improve the watershed, in-lake phosphorus management also needs to be implemented to restore Clear Lake and its value to the region.

EutroSORB® G is an effective and environmentally favorable phosphorus binding material that can be applied to lake sediments to prevent the release of phosphorus to the water column. If utilized to manage internal loading of phosphorus at Clear Lake in the near future, the outcomes would be improved water quality & ecosystem functions, improved cultural and recreational uses of the lake, increased economic development of the region, reduced burdens on the local institutions, and building up local capacity for stewardship of the lake and the watershed into the future.

To further assess this solution, EutroPHIX proposes performing a detailed sediment assessment (Task 1) and an initial field demonstration (Task 2) which will cost in total $3.38M. This project will be used to better determine long-term implementation costs and build a comprehensive plan for In-lake adaptive management of phosphorus. Additionally, this information will be very useful to other restoration efforts on Clear Lake such as development of a lake management plan, watershed and lake modeling, carp management, and oxygenation. These data, conclusions, and reports will be made publicly available for use by the local stakeholders for transparency and allowing other beneficial uses. We feel this proposal is well aligned with the mission and vision of the Blue Ribbon Committee (BRC) for determining restoration solutions for Clear Lake.

Background on Water Quality Issues

Multiple investigations have been performed to determine the causes of blooms and recommended interventions to restore water quality at Clear Lake (Richerson et al. 1994, Tetra Tech 2004, CVRWQCB 2006 & 2007, and references within). The consensus is that watershed loading from non-point sources of primarily sediments need to be controlled externally, but blooms are seasonally fueled by internal loading of nitrogen (N) and phosphorus (P) from the lake bottom. Internal loading drives a feedback mechanism driving long-term cyanobacteria and nutrient availability in Clear Lake (Figure 1). There is not enough denitrification, permanent burial deeper into the sediment, or export of N and P to reduce its magnitude. Breaking this internal cycle can be done with in-lake phosphorus management. Limiting internal phosphorus release from the sediment with in-lake management and continuing to reduce external loading of nutrients and sediment will quickly restore water quality at Clear Lake and ecological functions to a more natural state (Richerson et al. 1994 & supporting data from Tetratech 2004). Decades of watershed management has made significant progress towards watershed reductions

outlined in the TMDL (CVRWQCB 2021), but improvements in Clear Lake have not been realized and

likely is greatly inhibited by internal P cycling along with potential impacts from drought and fires in the watershed(highlighted in Visser et al. 2021).

Richerson, P.J., Suchaneck, T.H., Why, S.J. (1994) *The Causes and Control of Algal Blooms in Clear Lake*. Final Report, 1-182. Available at: http://www.des.ucdavis.edu/Faculty/richerson/CleanLakesReport1994.pdf

Tetra Tech (2004) *Total Maximum Daily Load for Nutrients in Clear Lake, Lake County, California Technical Report.* Final Report.

(CVRWQCB) Central Valley Regional Water Quality Control Board (2006) *Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Nutrients in Clear Lake.* Draft Staff Report. Available at: https://www.waterboards.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/clear_lake_nutrients/

(CVRWQCB) Central Valley Regional Water Quality Control Board (2007) *Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Nutrients in Clear Lake.* Resolution No R5-2006-0060.

(CVRWQCB) Central Valley Regional Water Quality Control Board (2021) *Clear Lake Nutrient TMDL Program Technical Memorandum.* Final Report. Available at: https://www.waterboards.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/clear_lake_nutrients/

Visser, M.A., Cannon, C., Panyanouvong, L. (2021) *Five Core Areas to Support and Promote Recovery to Natural Disasters: Insights from Tribal Communities in the Clear Lake Region.* Center for Regional Change. University of California, Davis.

EutroSORB G Overview

EutroSORB®G is a novel high-efficiency lanthanum modified bentonite containing 10% lanthanum embedded inside a clay matrix (90%). This formulation is an operational improvement requiring half the amount of material compared to historically used 5% lanthanum modified bentonite formulation. This improves logistics implementing projects of scale like Clear Lake and overall cost savings. EutroSORB G is highly specific to binding phosphorus, does not directly impact water chemistry, and is safe for humans and wildlife. EutroSORB G efficiently binds to phosphorus with a ratio of 50 pounds of material to bind 1 pound of phosphorus (1:1 La:P ratio). Bound phosphorus settles and incorporates into the sediments (Figure 2) as a non-bioavailable mineral called Rhabdophane ($LaPO_4 \cdot H_2O$) and this transitions to become more tightly bound through time to a more stable mineral, monazite ($LaPO_4$). After binding phosphorus, the bond is essentially permanent under any typical environmental conditions and more tightly than iron or aluminum salts. EutroSORB G binds phosphorus in the pH range of 5-9 then eventually stays bound from pH 4-11 and is not affected by low oxygen levels making it appropriate for the conditions at Clear Lake. EutroSORB G is manufactured in a granule which is applied as a slurry across a waterbody or treatment area from application vessels (Figure 3). Lanthanum modified bentonite also provides other benefits such as increasing sediment stability from resuspension which also increases nutrient flux (Egemose 2010) and may additionally bind arsenic (Cui et al. 20021) which is another contaminant of concern in Clear Lake.

Over 100 peer-reviewed publications exist on lanthanum modified bentonite that specifically address efficacy, fate, longevity and non-target impacts. Numerous standard ecotoxicity studies have also been performed on fish, water column invertebrates, and benthic invertebrates which all support a positive ecotox profile and no predicted toxicity concern at typical and recommended use rates (See Additional Information). The State of Washington Department of Ecology has also independently reviewed lanthanum modified bentonite to support its use in the state with essentially no restrictions (TRC 2017). Lanthanum modified bentonite has been used worldwide for decades to mitigate phosphorus in waterbodies, and can be integrated with other lake management approaches to achieve desired outcomes. 100s of lakes have been treated worldwide, and numerous large lakes and hundreds of small waterbodies utilize lanthanum modified bentonite on an annual basis in the United States. Lanthanum modified bentonite has been demonstrated to be effective for reducing phosphorus in Clear Lake already from a limited chamber study previously performed by SePRO and UC Davis (Fuhrmann et al. 2020). For specific US projects see case studies for Kitsap Lake, WA. Morrison Lake, MI, Lady Bird Lake, TX at www.eutrophix.com/case-studies and published work on Laguna Nigel, CA (Bishop et al. 2014). Additional project case studies and references can be provided upon request.

Lanthanum Modified Bentonite applications generally have not required state or federal permitting across the Unites States. Statewide in California there has not been a requirement to permit, but the San Diego Regional Water Board has developed a permit (CRWQCBSDR 2021). No SEIS, NEPA assessments have been required historically to implement these projects.

Egemose, S., Reitzel, K., Anderson, F.O., Flindt, M. R. (2010). Chemical Lake Restoration Products: Sediment Stability and Phosphorus Dynamics. *Environmental Science & Technology, 44*, 985-991. DOI 10.1021/es903260y

Cui, J., Wang, D., Lin, J., Wang, Y., Ren, M., Yang, Y., & Shi, P. (2021). New application of lanthanum-modified bentonite (Phoslock®) for immobilization of arsenic in sediments. *Environmental Science and Pollution Research*, *28*, 2052-2062.

TRC (2017). Supplemental Environmental Impact Statement for State of Washington Aquatic Plant and Algae Management. *Final Report*. Publication No. 17-10-020. Available at: https://apps.ecology.wa.gov/publications/documents/1710020.pdf

Fuhrmann, B., Jones, A., Cortes, A., Vaughn, L. (2020). Enhancing Water Quality with Phosphorus Binding Technology. *Presentation*. Available at: https://resources.ca.gov/Initiatives/Blue-Ribbon-Committee-for-the-Rehabilitation-of-Clear-Lake/clearlake-technical-subcommittee-meeting-13

Bishop, W.M, McNabb, T., Cormican, I., Willis, B.E., Hyde, S. (2014). Operational Evaluation of Phoslock Phosphorus Locking Technology in Laguna Niguel Lake, California. *Water Air Soil Pollution* 225:2018. DOI 10.1007/s11270-014-2018-6

(CRWQCBSDR) California Regional Water Quality Control Board San Diego Region (2021). General National Pollutant Discharge Elimination System Permit for the Discharge of Lanthanum-Modified Clay to Surface Waters of the United States in the San Diego Region. *Order R9-2021-0056*. Available at: https://www.waterboards.ca.gov/sandiego/board_decisions/adopted_orders/2021/r9-2021-0056.pdf

In-Lake Adaptive Management Process for Phosphorus with EutroSORB G

EutroPHIX is proposing to perform the first steps of a multi-year process to address excess in-lake sediment phosphorus. We propose doing 1) a detailed sediment assessment and 2) an initial field demonstration that could be used to better determine long-term costs and build a detailed plan for a In-lake phosphorus management. Over a relatively quick timeline achieve substantial progress towards the mission and vision of the BRC for Clear Lake of improving water quality and reduce HABS. This process would utilize adaptive management principles to reach projects goals by continuously following a process of assessment, prescription and plan, implementing management and monitoring results to inform later management (Figure 4). It is essential to involve the community in the assessment phase and our proposal includes community outreach events for the public and Tribal communities to learn about this potential projects, ask questions, and provide feedback that could be used to enhance this effort. Once our proposed project is performed, EutroPHIX can work with local stakeholders to develop a detailed implementation plan on fully implementing this solution. If the BRC and local stakeholders finds this plan desirable for full scale implementation, EutroPHIX can work with the BRC to gain additional state and federal funding for full implementation. At this point, we believe it is reasonable that implementation to address the magnitude of the internal phosphorus a Clear Lake is in the region of $100M (this will be refined by performing the first task for $150k). Realistically implementation will be limited by the timing and availability of funding. A project of this scale can effectively be implemented over a period of a couple years or spread out over a longer time frame such as 20 years.

Outcomes & Success: Managing internal loading of phosphorus should drastically improve water quality towards natural conditions providing a multitude of ecosystem benefits. A more phosphorus-limited system and improved nitrogen to phosphorus rations will support a better composition of phytoplankton that is better incorporated in the food web and important fishes. Ultimately, a reduction in HAB severity and occurrence should occur. These improvements to the water quality and ecosystem will positively impact and improve cultural uses, recreation, tourism, and economic development for the area. Additionally, this would alleviate drinking water processing plants burdens processing clean and safe that are impacted by HABS today. Another benefit of this approach is there would be no need to develop additional infrastructure or fund constant operations and maintenance (as suggested by other solutions/proposals). Improvements in water quality should reduce the burden of dealing with HAB symptoms and allow more focus to be put into stewarding the lake and continuing watershed improvements. Any project partnerships with local stakeholders should provide great additional experience increasing local knowledge capacity to manage Clear Lake, and the process we look to engage for gaining additional state and federal funding will allow local institutions and the BRC to gain more political capacity. Overall, the outcome of this project we feel aligns well with the vision and goals outlined by the BRC.

Task 1) Initial Sediment Assessment of Clear Lake

Goal: Perform a detailed quantification of phosphorus and sediment characteristics across Clear Lake to gain a better understanding of lake sediment, internal loading of phosphorus, and phosphorus burial. This information will provide data required for building dosing for sediment phosphorus mitigation and critical information needed for a lake management plan, lake modeling, and other management actions (carp management, oxygenation, etc.).

Description: An initial lake wide sediment assessment would take place to better quantify the mass of mobile phosphorus and potentials to release based on water column and sediment characteristics (sediment P fractionation, redox, organic matter, and sediment characteristics analyses, see Additional Information). Currently there is only sediment phosphorus data from 4 locations within the lake which can only allow limited approximations. We would hold a community outreach event for the public and Tribal communities to learn about this sediment assessment, ask questions, and provide feedback that could be used to enhance this effort. To improve public outreach we will create one video describing the problems at Clear Lake, overview of a sediment assessment, and how this information will help restore Clear Lake. Through both of these efforts we can effectively engage all interested stakeholder groups and Tribal nations to optimize outcomes.

Sediment Sampling: Collection sites will be stratified by the various arms of the lake (upper arm, lower arm, oaks arm) and depth strata. Approximately 54 surficial sediment samples (top 4cm) will be collected for phosphorus fractionation and 27 surficial sediment samples for phosphorus fractionation + sediment characteristics (Level 3, see additional information). Sediment cores will be collected at 9 locations in the lake and sectioned (0-20cm) for phosphorus fractionation. Sediment cores will be used to determine sediment diagenesis of phosphorus (long-term release and burial dynamics). We would additionally collect water samples at 18 sites for total and free reactive phosphorus from the surface, middle, and bottom waters at the time of sampling. A total of 90 sites will be sampled for sediment.

Outcomes & Success: This information will provide data required to better estimate the mass of phosphorus interacting with the water column for building dosing for sediment phosphorus mitigation. This information will also provide data and conclusions very useful to other efforts to restore Clear Lake such as development of a lake management plan, watershed and lake modeling, and other management actions such as carp management and oxygenation. These data, conclusions, and reports will be made publicly available for use by the local stakeholders and allow for more transparent communication and use. EutroPHIX is planning to work with Lake County and the Robinson Rancheria Tribe to utilize information gained which will provide great additional experience increasing local knowledge capacity to manage Clear Lake. EutroPHIX is also open to additional partnerships with Clear Lake stakeholders. Overall, the outcome of this project we feel aligns well with the vision and goals outlined by the BRC.

Timeline:

After funding is obtained the initial assessment process should likely only take 2-4 months after sediment sampling can occur to do the lab analyses, data analysis, and reporting. The public outreach video will take about 1-2 days to film and 2-4 months to publish. Once a report is developed, we can communicate this information to the BRC and make the data publicly available.

Task 2) In Lake Demonstration of EutroSORB G

Goal: A demonstration that quantifies P binding effectiveness, engages the community, and leverages success for further implementation. This is also a significant start to mitigating sediment phosphorus.

Description: Application of EutroSORB G in an area around the deepest part in the Upper Arm or Lower Arm of Clear Lake pending community feedback. The Upper Arm is a key area where HAB blooms often develop in this region of the lake and are transported to Oak Arm & Lower Arm by westerly winds. The Lower Arm of Clear Lake is deeper and has higher flux rates of phosphorus from the sediment (Framsted et al. 2020). 1 lb. of phosphorus can support the growth of up to 500 lbs. of algae. This application would permanently bind 14,500 lbs. of biologically available phosphorus. We propose an application of 725,000 lbs. of EutroSORB G to an area approximately 2,900 acres or smaller (Figure 5) would address around ¼ - ½ of the mobile P in the sediment of the application area, significantly reducing flux rates.

Monitoring: This project would primarily monitor sediment P fraction transformations over a 2-year period along with water quality changes. When EutroSORB G binds phosphorus it becomes very tightly bound and can be quantified in the apatite fraction of sediment phosphorus fractionation methods (See Additional Information). Multiple sediment samples of the top 4cm (9 replicates) will be collected to determine this binding across time by sampling before application, 4-month post, 1-year post, 1.5-year post, and up to 2-year post. During each sediment collection for phosphorus, water samples from the surface, middle, and bottom waters will be collected to determine total and free reactive phosphorus. The existing lake monitoring program can be leveraged to provide additional phosphorus readings of surface and near bottom water for the section of Clear Lake across the study period.

Lanthanum will also be monitored during this project. Sediment samples would be collected before and after application to determine changes in lanthanum concentration in surficial sediments. Water samples will be collected before, during, and after application to monitor dissolved lanthanum in the water column.

Community Outreach: After gaining approval from the BRC for this project, we would hold a community outreach event for the public to learn about the potential project, ask questions, and provide feedback that could be used to enhance this effort and determine which location on the lake for the demonstration. Additionally, we would make sure to engage interested stakeholder groups and Tribal nations to optimize implementation planning and outcomes. Any changes to the demonstration plan would be shared before application begins.

Outcomes & Measuring Success: This demonstration would permanently bind 14,500 lbs. P released in Clear Lake. Due to the current condition of the lake and limited scale of this demonstration, large water quality improvements may not be realized, but there will be quantifiable water column phosphorus reductions and sediment phosphorus binding dynamics gathered. Quarterly updates will be provided to the BRC, and a final report generated after the last set of samples are included in the analyses. These data in combination with the initial sediment assessment will be useful in developing a lake management plan for the sediment phosphorus. The project results will be presented to the community and externally to leverage this success for further implementation of this solution on Clear Lake. We will produce two informational project videos of the project documenting the project and successful outcomes to improve communication across a diverse audience and funding entities.

Timeline: After funding is obtained, and community outreach has been completed the demonstration would occur. Ideally the application of EutroSORB G would occur when the lake sediments are relatively oxygenated and saturated with redox sensitive P (fall-early summer). Monitoring would take place before application and continue throughout the summer into the following spring or summer. We expect the monitoring for this project to wrap up approximately 1.5 - 2 years after the application of EutroSORB G.

Framsted, N., Sadro, S., Forrest, A., Schladow, G. (2022) *Nutrients from the deep: internal phosphorus loading in hyper-eutrophic Clear Lake*. Poster. Available at: https://clearlakerehabilitation.ucdavis.edu/news/getting-bottom-what-fuels-algal-blooms-clear-lake

Proposed Budget

Task	Item	Description	Price
1.1	Sediment & Water Sampling	- Sampling - Sediment + Water analysis - Shipping & supplies	$106,115
1.2	Community Outreach + Media	- Public outreach meeting with community - Production of informational video	$23,100
1.3	Data Analysis & Reporting	- Quarterly updates - Data analyses and report	$19,600
2.1	Sediment Sampling & Analysis	- Sampling - Sediment + Water analysis - Shipping & supplies	$88,906
2.2	EutroSORB G Application	- 725,000 lbs. of EutroSORB G & Shipping - Application - Project management	$3,076,150
2.3	Community Outreach + Media	- Project community outreach meetings - 2 Project informational videos	$46,200
2.4	Reporting	- Quarterly updates - Final project report & presentation	$19,600
		Total	**$3,379,671**

EutroPHIX: A Guide for Improving Water Quality

EutroPHIX is focused on accelerating water resource restoration from the impacts of nutrient pollution and harmful algae blooms. Our team has over 100 years combined experience and have been guiding water resource restoration for over 25 years. For every project we provide a clear path for stakeholders through a proven management process of assessment, prescription, and implementation to restore water quality. EutroPHIX operates as a division of SePRO Corporation. SePRO is a research-based life sciences company providing innovative products and services for aquatic resource management. SePRO is dedicated to discovering and developing sustainable solutions to provide aquatic plant management, algal/cyanobacterial management, and phosphorus mitigation solutions for water resource management. EutroPHIX and SePRO have extensive experience in successful support of public lake and reservoir management throughout the country providing products and advanced technical services to manage hundreds of thousands of acres of surface water throughout the US on an annual basis. Visit www.eutrophix.com for more information.

Contact Information:

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Additional Information:

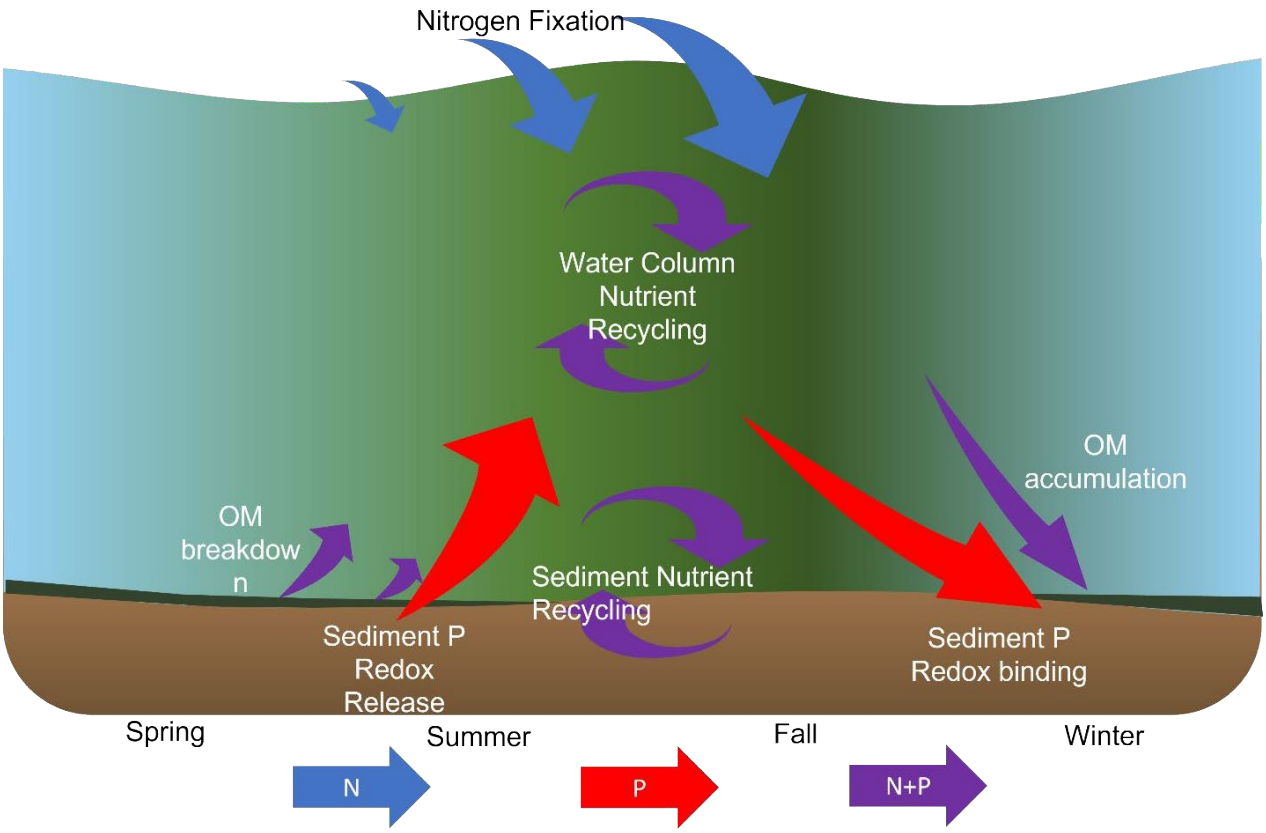


Figure 1: Cyanobacteria-mediated internal loading dynamics in a hypereutrophic lake. During the summer, algae and cyanobacteria production deposits organic material (OM) to the sediments. The following year, bacterial decomposition of OM increases as the water warms which results in increasing sediment oxygen demand (SOD) and releasing stored N and P. When SOD depletes dissolved oxygen in the overlying waters it causes large areas of sediment in the lake to become anoxic, releasing massive amounts of phosphorus from redox sensitive phosphorus bonds. After excess phosphorus is made available, nutrient limitation assays have demonstrated that iron and nitrogen are limiting in these conditions. But, nitrogen-fixing cyanobacteria can assimilate nitrogen from the atmosphere to bypass this limitation and further fuel its production. As the bloom dies this assimilated N and P deposits to the sediment and OM accumulates as water temperature decrease into the winter This process keeps an excess of N and P biologically mobile, year after year inside the lake.

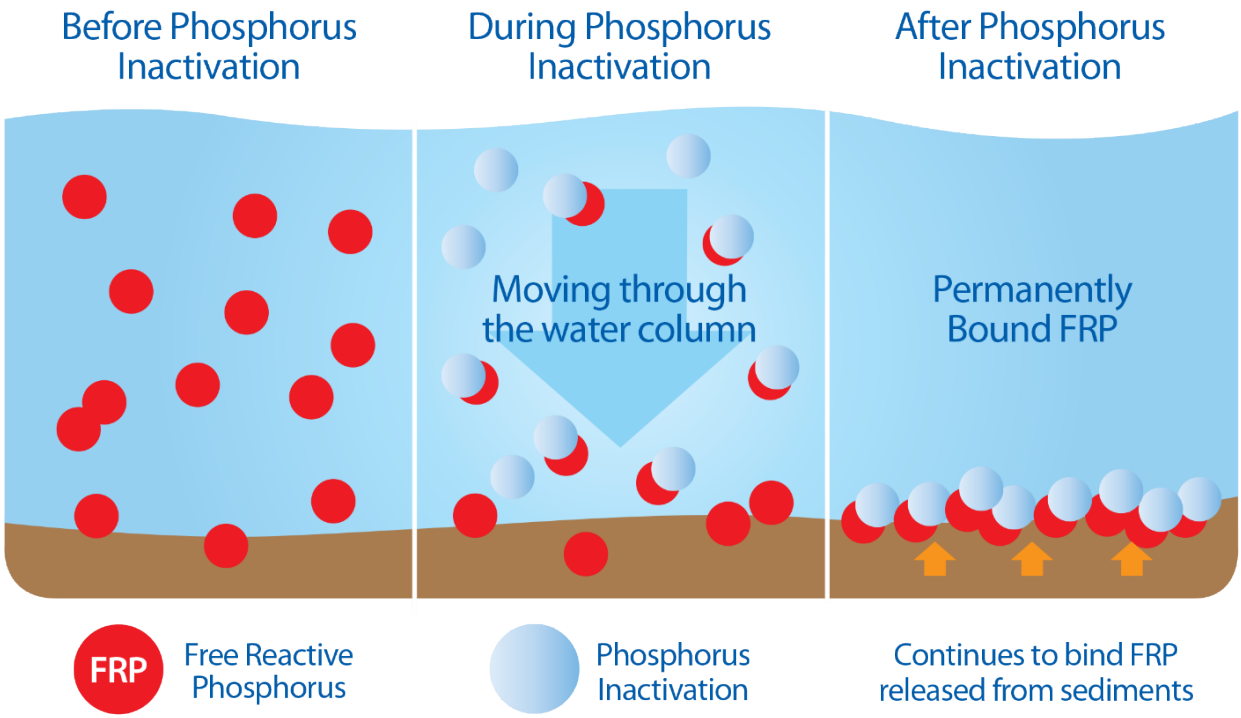


Figure 2: EutroSORB G disperses and sinks through the water column binding free reactive phosphorus rapidly, then settles on the bottom. EutroSORB G with available binding sites will continue to bind FRP released from the sediments due to OM breakdown, pH swings, or anoxia. EutroSORB G will mineralize this phosphorus and incorporate into the sediment profile over time.

Figure 3: Lanthanum modified bentonite application to Kitsap Lake, WA. The application vessel travels in a grid pattern over the application zone while the slurry is dispersed and settles through the water column over a period of hours-days.

Figure 4: Diagram of Adaptive Management Process of Assessment, Prescription, and Implementation to continuously manage a waterbody to achieve management and stakeholder objectives.

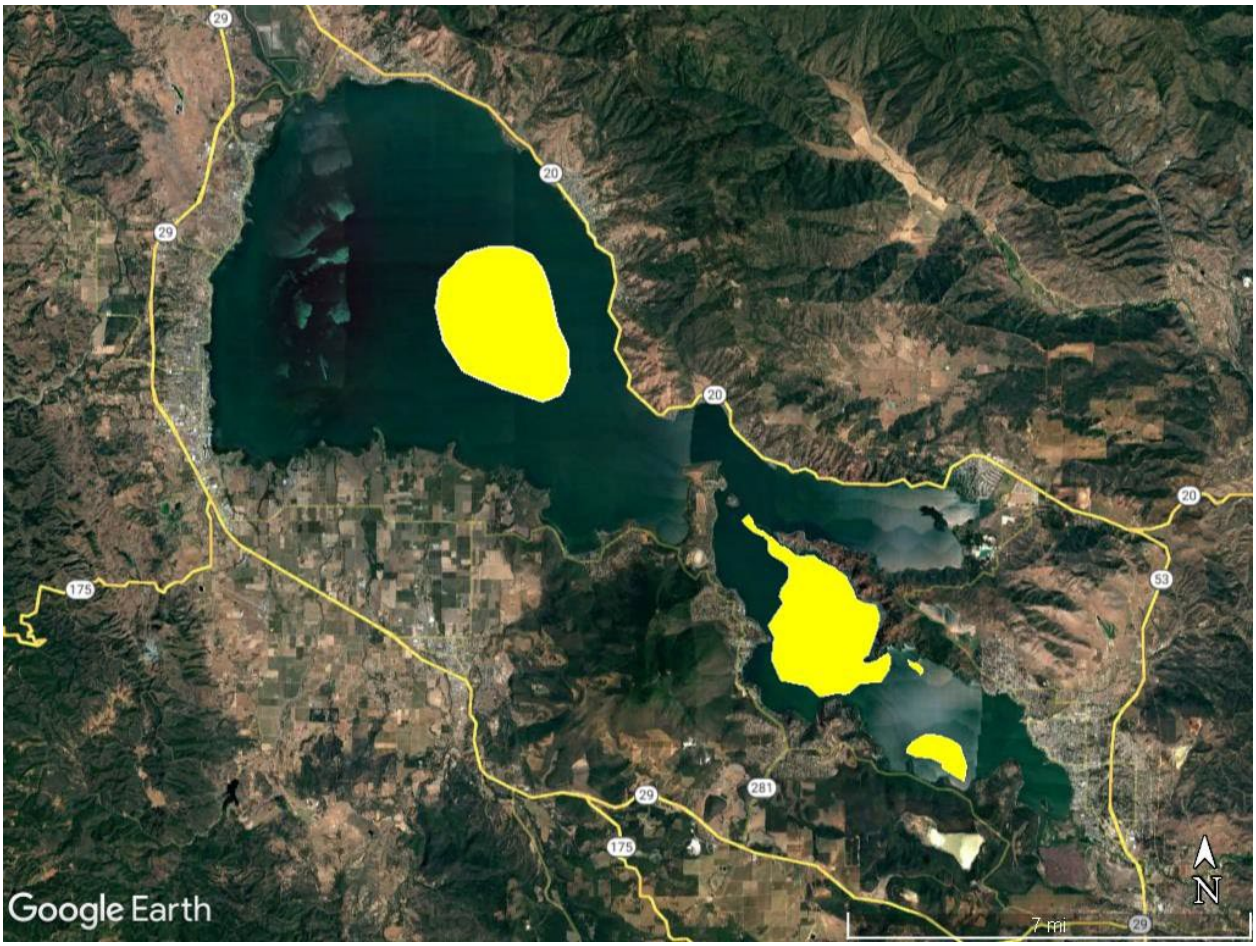


Figure 5: Potential Implementation areas in the Upper Arm (2900 acres) and Lower Arm (~2640 acres) indicated by yellow polygons.

Clear Lake Sediment P Estimates

Mobile Sediment Phosphorus Estimates					
Lake Area	**sediment depth, m**	**Mobile P, mg P/kg DW (Loosely bound + Iron Bound + Difference in Residual Bound)**	**% solids**	**Mobile P in Sediment, mg P/L**	**Mobile P, Lbs. P/acre**
Upper Arm	0.04	359.2	15.47%	55.6	19.8
Lower Arm	0.04	581.7	10.61%	61.7	22.0
Oaks Arm	0.04	505.6	11.34%	57.3	20.5

Formulas:

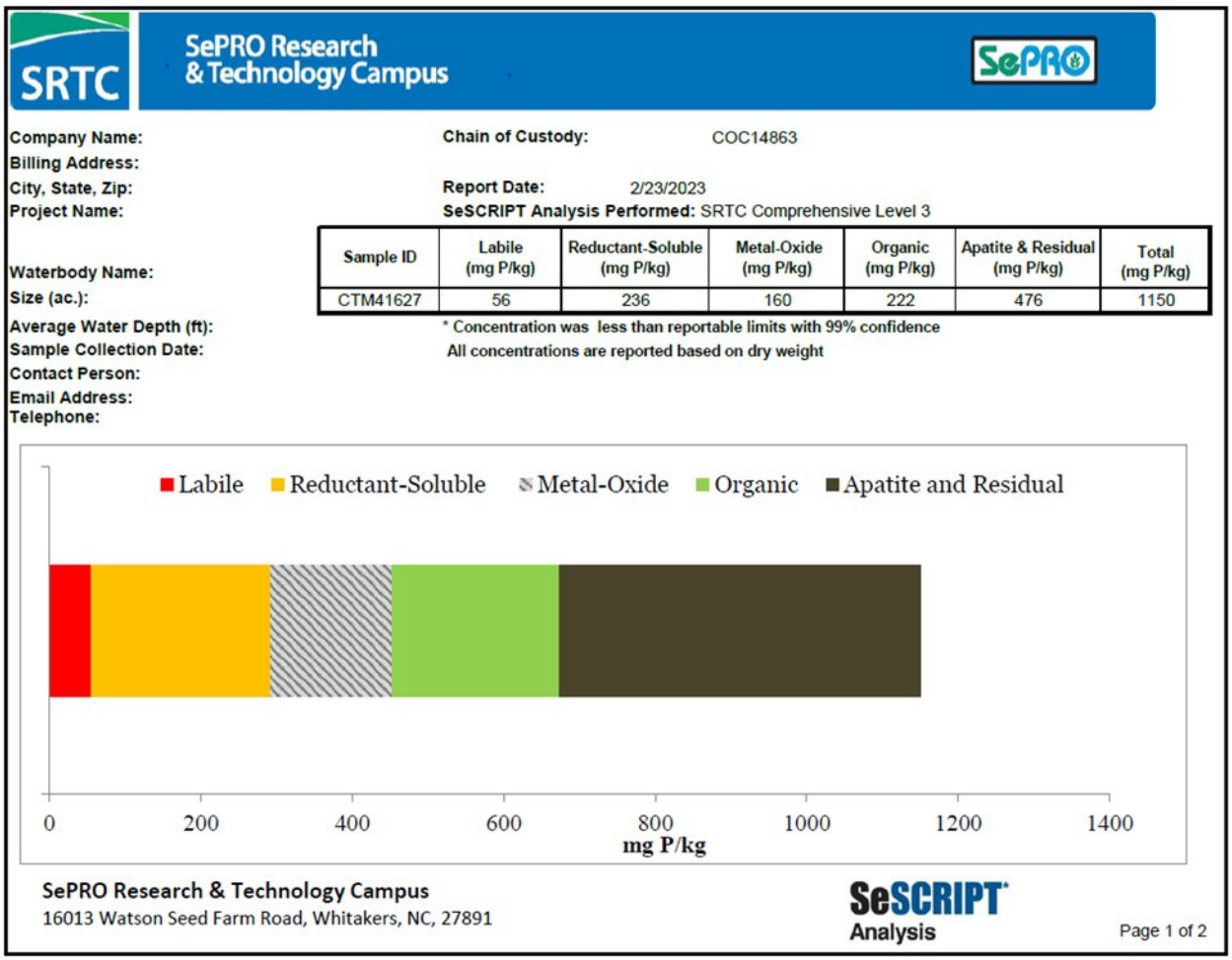
Mobile P in Sediment (mg P/L) = Mobile P (mg P/kg DW) * % solids (kg DW/L)

Mobile P (lbs. P/acre) = 4046 m^2/1acre * sediment depth (m) * 1000L/1m^3 * Mobile P in sediment (mg P/L) * 1kg/1,000,000mg * 2.2046 lbs./1kg

Framsted, N., Sadro, S., Forrest, A., Schladow, G. (2022) *Nutrients from the deep: internal phosphorus loading in hyper-eutrophic Clear Lake*. Poster. Available at: https://clearlakerehabilitation.ucdavis.edu/news/getting-bottom-what-fuels-algal-blooms-clear-lake

Lake County (2021) *Clear Lake Ambient Water Quality Monitoring Program (CLLAMP) Data Hub.* Website : https://clear-lake-ambient-water-quality-lakecountywrd.hub.arcgis.com/

Sediment Analysis Example and Parameters



SRTC SePRO Research & Technology Campus

SePRO

Company Name:
Billing Address:
City, State, Zip:
Project Name:

Waterbody Name:
Size (ac.):
Average Water Depth (ft):
Sample Collection Date:
Contact Person:
Email Address:
Telephone:

Chain of Custody: COC14863

Report Date: 2/23/2023

SeSCRIPT Analysis Performed: SRTC Comprehensive Level 3

Sample ID	Labile (mg P/kg)	Reductant-Soluble (mg P/kg)	Metal-Oxide (mg P/kg)	Organic (mg P/kg)	Apatite & Residual (mg P/kg)	Total (mg P/kg)
CTM41627	56	236	160	222	476	1150

* Concentration was less than reportable limits with 99% confidence
All concentrations are reported based on dry weight

SePRO Research & Technology Campus
16013 Watson Seed Farm Road, Whitakers, NC, 27891

SeSCRIPT Analysis

Page 1 of 2

SRTC SePRO Research & Technology Campus

Sample ID:
CTM41627

Level 3 Data - Contact for EutroPHIX Representative for Interpretation and Guidance

Parameter	Result	Category	Description
% Solids	14.4%	Diffusion	Solids content of sediment.
% Porosity	60%		Amount of pore space within sediment.
Dry Bulk Density	0.69 g/cm^3		Density of the solids within sediment.
% Sand	41%		Sand content of sediment.
% Silt	41%		Silt content of sediment.
% Clay	18%		Clay content of sediment.
% Labile Organic Matter (OM)	10.2%	Organic Matter	Easily degradable organic matter content of sediment.
% Total OM	20%		Labile and refractory organic matter content.
Labile to Total OM Ratio	50%		What percent of total OM is labile?
% Reduced Manganese	74%	Redox Properties	What percent of sediment manganese is dissolved?
% Reduced Iron	0.7%		What percent of reducible iron is dissolved in sediment?
Reducible Iron-oxide/hydroxides	1,391 mg/kg		Sediment concentration of redox sensitive iron minerals.
Total Recovered Sediment Fe	2,134 mg/kg		Total iron recovered from sediment.
Reductant Soluble Fe:P Ratio	3.3		How efficiently does iron bind phosphorus within sediment?
pH	7.0	Metal Oxide Fraction	pH of sediment sample.
Metal-Oxide Al:P Ratio	14.4		How efficiently does aluminum bind phosphorus within sediment?
Metal-Oxide Al:Fe Ratio	5.7		Ratio of aluminum to iron in metal-oxide fraction.

EutroSORB G Environmental Information

Lanthanum is a naturally occurring earth element. A soil study conducted by the University of California detected lanthanum at an average background level of 20.3 mg La/kg in soil samples collected throughout California (Bradford et al. 1996). To further assess and manage possible environmental impacts of a product, it is important to understand the potential risks associated with its use. When EutrosORB G is applied to water, lanthanum associated with the clay preferentially and rapidly binds with phosphate (PO_4), forming a highly stable mineral called rhabdophane ($LaPO_4$). This resulting rhabdophane complex has a very low solubility ($K_{sp} < 10^{-27}$) and is not influenced by changes in pH and redox reactions in waterbody sediments, thus is not bio-available. Lanthanum can only be extracted from rhabdophane in the laboratory using strong acid extraction methods (SePRO 2012). Laboratory studies with EutroSORB G demonstrate that minimal lanthanum (~0.1%) is released within 24 hours when granular EutroSORB G (250 mg/L) was dissolved in nano-pure water (unpublished). **Typical EutroSORB G application rates are < 75 mg/L, applications to Clear Lake are expected to be <30 mg/L.** EutroSORB G applications may occur as a single event or over several days and also may be split over a season or multiple seasons depending on the site and management objective (further reducing in water concentrations or minimizing impacted area on a waterbody per day).

In general, a variety of acute and chronic studies conducted for vertebrates, invertebrates, and plant species have shown that lanthanum toxicity is generally very low. There are generally 2-5 orders of magnitude difference between application rate and toxicity. No mortality or adverse impacts to fish have been observed in field applications in the United States or internationally. Based on data generated for several different fish species with lanthanum modified bentonite there is minimal risk to fish expected with applications at standard dose rates in aquatic environments. Results of a rainbow trout acute study (5% LMB) yielded a 96-hour LC^{50} value of greater than 3,125 mg/L, and a 48-hour LC^{50} value of greater than 13,000 mg/L (SePRO 2012). Mortality test on zooplankton using *C. dubia* in laboratory water yielded a 48-hour mortality LC^{50} value of greater than 12,500 mg/L, and a similar study using the daphnid *D. magna* in laboratory water yielded a 48-hour mortality LC^{50} value of greater than 50,000 mg/L (SePRO 2012). Regarding potential exposure to benthic macroinvertebrates inhabiting lake and pond bottom sediments, when lanthanum settles at the sediment-water interface it forms a thin layer that is neither reactive nor bioavailable to benthic organisms. Eight benthic invertebrate studies (5% LMB) studied a wide range of response variables, including lethality, emergence time, growth, and sex ratio produced at emergence. LOECs were calculated for each of these tests, and produced a range of LOEC values from 400 mg/L to 50,000 mg/L (SePRO 2012). These results uniformly demonstrated that no significant impacts or toxicity to these invertebrates occur at or even above anticipated use rates for lanthanum modified bentonite. In addition, no field toxicity has been observed in invertebrate species (TRC 2017). Additional studies and citations can be provided. The margin of safety associated with lanthanum modified bentonite toxicity is very high.

There is a very low potential exposure for humans to lanthanum in EutroSORB G after being applied due to the minimal bio-availability. EutroSORB G and associated lanthanum quickly settles to the lake sediments. Even if an exposure occurs, lanthanum is readily processed by the liver and excreted with no negative impacts observed. Lanthanum is used in a prescription drug called Fosrenol® to decrease blood phosphate levels in humans. The Food and Drug Administration approved human dose rate for Fosrenol is 750 to 3,000 mg/day. A person would need to drink 100s of gallons of water (during application) to receive a dose of La comparable to Fosrenol daily intake. Drinking EutroSORB G treated water directly after an application would pose negligible risk to human health. The risk via consuming EutroSORB

G/lanthanum in fish harvested from treated water after application is negligible as tested by field study. Fish accumulate low levels of lanthanum only in liver and hepatopancreas tissues, not in the flesh/muscles (consumable), and concentrations of lanthanum return to baseline concentrations within a few months (Landman et al. 2007). Consumption guidelines for fish at Clear Lake suggest that only 1-7 servings of fish/week are recommended due to methylmercury concerns (OEHHA 2018).

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Landman M., Brijs J., Glover C. and N. Ling. (2007). Lake Okareka and Tikitapu Fish Health Monitoring, 2007. *Scion Report*. October 2007.

(OEHHA) California Office of Environmental Health Hazard Assessment. (2018). *Clear Lake Advisories*. Accessible at: https://oehha.ca.gov/advisories/clear-lake

Addendum: Improving Restoration Efforts at Clear Lake with In-Lake Management of Phosphorus Addendum to Address Committee Proposal Requirements

Date: May 5th, 2023

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

   There has been a nutrient TMDL process being implemented by local stakeholders to control external inputs and improve the watershed, yet in-lake phosphorus management also needs to be implemented to restore Clear Lake and its value to the region. This project is for an initial assessment and field demonstration of a solution that looks to significantly reduce internal loading of phosphorus by applying an effective and environmentally favorable phosphorus binding material, EutroSORB®G to the lake sediments. This solution is viable to fully scaling within Clear Lake to stop internal loading of phosphorus, speed up ecosystem recover time and maintain desirable water quality and biological health while remaining nutrient loading reductions in the watershed are achieved.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

   The key drivers of poor water quality are watershed loading of sediment and nutrients, internal nutrient loading, and dominance of toxic cyanobacteria. The prolific harmful algae blooms (HABs) on Clear Lake are some of the worst in the United States and has deteriorated ecosystem services provided and limited economic opportunity and growth of the local economy for decades. This project looks to significantly reduce internal loading of phosphorus to get nutrient levels and resulting biological measures much closer to a natural and desired state (reduced extent and severity of HABs, and <63 ug/L Chla outlined by 2006 TMDL).

3. How does the project demonstrate progress towards achieving the Committee's vision?

   This project outlined is a taking the first steps to utilizing a sustainable solution that can help rehabilitate Clear Lake by mitigating key sources of water quality issues (not just HAB symptoms or continued investigation) while building local collaboration to implement, reduce burden of HAB impacts, and build local capacity to further manage the lake via knowledge/experience and political capital via funding process.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

   As of the time of this addendum (see above) we have been able to have meetings with Environmental Directors from the Habematolel Pomo of Upper Lake and Robinson Rancheria Tribes. Our proposal would provide significant value to the work of Robins Rancheria Carp

Management project in evaluating the impact of carp on internal loading and benefits of management and opportunities to work together here. We have had communications with Big Valley Band of Pomo Indians, but are still trying to setup a meeting time. We will continue our outreach efforts with the Elem Indian Colony, Scotts Valley Band of Pomo Indian. We understand the value in this and working to bridge this gap. Within this proposal we additionally outline community outreach for the public and Tribal nations to gain additional insights before any implementation of the EutroSORB G demonstration takes place. In the development of a full lake implementation plan, EutroPHIX would seek to understand how much involvement and building of local capacity (implementation, monitoring, political capital via funding processes) is desired from the Tribal governments and representatives.

5. How will the fully implemented project be maintained in the long-term with the local community?

   Unlike other projects, there is essentially no physical infrastructure to be developed or operations and maintenance capacity left for the local community to find a way to support long-term. This proposal would likely be funded through the BRC process. At full implementation of this in-lake management process there should actually be reduced burdens on the local community and allow them to reallocate time, people, and resources towards other stewardship efforts (Clear Lake Hitch, watershed improvements). Simply, EutroSORB G gets applied to the lake and binds phosphorus in the sediments and keeps it permanently bound. The only "maintenance" long-term is that internal loading would slowly recover to a new equilibrium (more natural levels) after full implementation. If the required watershed improvements or TMDL reductions are not achieved by that time (generally 10-30 years after this project starts), internal loading may redevelop in magnitude above natural levels that maintain physical and biological health of the Lake and additional dosing may be needed to further maintain beneficial conditions.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.

   This proposed project will likely have minimal impact on the Lake County economy. When this solution is taken full scale, we would expect that quickly improved water quality in the whole lake will allow for significant increased recreational and tourism activities to drive local economic growth. It was estimated in the 1990's that $7M per year in economic activity was lost due to the sharp increase in HABs on Clear Lake (Richerson et al. 1994). In today's dollars that would be ~$14M/yr, and over $300M of potential economic opportunity not realized since time of that estimate. Harmful Algae Blooms also depress property values up to 11-17% (Wolf and Klaiber 2017).

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.

   Projects like this need strong community support to gain funding and be successfully implemented. In this proposal we outline a process of holding community outreach events for the public to gain awareness and support, ask questions, and provide feedback that could be used to enhance this effort. Additionally, we are engaging interested stakeholder groups and Tribal nations to optimize implementation planning and outcomes. We would plan to produce informational project video(s) of the project and successful outcomes to improve communication across the local community and outward to political and funding institutions. Due to the importance of this element, we are open to adapting these plans as needed through the lifespan of the project to improve engagement.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.

   Lanthanum Modified Bentonite (EutroSORB G) applications generally have not required state or federal permitting across the Unites States. Statewide in California there has not been a requirement to permit, but the San Diego Regional Water Board has developed a permit (CRWQCBSDR 2021). No SEIS, NEPA assessments have been required historically to implement these projects. We have experience implementing projects like this and engaging all federal partners to determine permit needs or developing a permit to support the work outlined in the proposal.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

   Internal nutrient cycling on Clear Lake has been identified and quantified for over 3 decades. This project looks to perform a detailed sediment analysis required to implement a solution. The field demonstration component would confirm validity of the approach in the unique conditions of Clear Lake (pH, sediment disturbance) and in combination gain information to optimize full scale implementation and cost estimates. Lanthanum Modified Bentonite (EutroSORB G) also has extensive research (over 100 peer reviewed publications) on its efficacy, fate, longevity, and non-target impacts and successful implementation worldwide for over 20 years. This project leverages these data and conclusions to implement phosphorus management that will lead to restoring Clear Lake and does not look to re-perform primary research.

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

UC-Davis has performed assessment on a limited quantity of sediment cores to quantify sediment phosphorus flux (rate of release). One piece of data this project looks to gain is a better representation and quantification of the total mass of phosphorus that may be mobilized in the sediment. We currently only have data from 4 sample locations for a few recent years which does not provide good representation across a 44,000 acre lake. These data are critical to quantifying estimates of mobile phosphorus in the system for mitigation purposes, but will also have great value towards lake management planning, lake modeling efforts, carp management, and oxygenation pilots.

11. Describe the proposing entity's experience on similar projects.

    EutroPHIX is focused on accelerating water resource restoration from the impacts of nutrient pollution and harmful algae blooms. Our team has over 100 years combined experience and have been guiding water resource restoration for over 25 years. We specifically provide innovative phosphorus mitigation products, technical services, and turn-key project implementation across the United States. For this type of work 1,000 acres, 10,000 acres, or 44,000 acres are functionally the same. On projects of the scale as Clear Lake we develop a greater project team to implement, monitor, and to build local capacity and best achieve project goals. For specific US projects examples see case studies for Kitsap Lake, WA. Morrison Lake, MI, Lady Bird Lake, TX at www.eutrophix.com/case-studies. Additional projects can be shared upon request.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

    EutroPHIX is a private U.S. company, and we have no statutory or regulatory responsibilities to address by leading this effort. We look to build a project team, engage local entities, and alleviate burdens on those entities that do have these statutory and regulatory responsibilities.

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Scott De Leon
Water Resources Director

Marina Deligiannis
Deputy Water Resources Director

May 1, 2023

County of Lake Letter of support for the proposed HAB Mitigation project titled "Improving Restoration Efforts at Clear Lake with In-Lake Management of Phosphorus" being proposed and managed by EutroPHIX.

Dear Blue Ribbon Committee,

We are writing to you today to communicate that we, at County of Lake Water Resources Department and the Lake County Watershed Protection District, are in full support of the proposed Harmful Algal Bloom (HAS) mitigation project being proposed by **EutroPHIX** titled **"Improving Restoration Efforts at Clear Lake with In-Lake Management of Phosphorus".** We believe that this project is one of the best options being presented to the Blue Ribbon Committee for preventing nutrient mobilization from the lake sediment into the water column. Additionally, EutroPHIX has demonstrated that they are committed to be long-term partners and collaborators with Lake County and other local agencies and tribes, to share data, identify funding sources, and participate in long-term sustainable management planning for Clear Lake.

Lake County Water Resources has been designated the Clear Lake managers by the State of California Lands Commission and is charged with managing the lakebed to provide for future generations of wildlife and people. The proposal submitted by EutroPHIX will help to satisfy that charge by providing long-term solutions to reduce nutrient resuspension into the water column that has been demonstrated to be responsible for noxious cyanobacterial blooms in the summer and fall months. Concurrently, EutroPHIX will conduct a much needed sediment assessment, to identify the role of sediment nutrients in contributing to the current state of Clear Lake. This sediment assessment is necessary for lakebed sediment management projects to be effective and the products of this assessment will be useful as a chapter in the Watershed Protection Districts proposed **Lake Management Plan** - which is also proposed to the Blue Ribbon Committee this funding cycle.

We also support this proposal in tandem with the **LG Sonic Buoys** being proposed and sponsored by Water Resources Department. Together, these joint projects will reduce the nutrient phosphorus resuspension in the water column, where EutroPHIX is applied, while the LG Buoys will prevent the formation of nuisance cyanobacteria in the high-priority shallow zones such as those around drinking water intakes and high recreation areas.

Its clear EutroPHIX will work in combination with other projects to maximize its benefit and further justify its cost and to expand the beneficial impact to overall improvement of Clear Lake. As the current state-designated lake managers, we reiterate our support for the EutroPHIX project proposal and hope that the Blue Ribbon Committee will strongly consider approving this proposal for funding so that we can continue to work together to improve Clear Lake for future generations of wildlife and people.

Sincerely,

Y'(\u:ruN-O..)

Marina Deligiannis, Deputy Water Resources Director
County of Lake Water Resources Department

4/30/23

Letter of Support from Jim Steele for EutroPhix Algae Mitigation Proposal

Please provide the following recommendation to the BRC for the **Eutrophix in-lake phosphorus [P] inactivation pilot-project for Clear Lake**. This pilot project if scaled up would directly benefit the lake by bringing into balance the P/nitrogen [P/N] ratio for nutrient circulation. This will encourage eukaryote phytoplankton production over prokaryote cyanobacteria production.

Several key drivers have increased nutrient loading in the lake over decades, including upland watershed disturbances such as roads, lots, agricultural, instream gravel mining, impervious surfaces, mineral mining and off-road vehicles. In addition, sediment settling areas such as wetlands have been compromised through levee bypass channels and in-filling for useable land. Nutrients contained in erosion such as P can recycle in the lake adding to the new inputs from the upland. This increases the total available P to enhance harmful algal blooms [HABS].

Even if upland inputs were to return to European pre-contact times, the remaining P would recycle as internal loading for probably decades to come. A two prong water basin plan is needed. **First lower upland inputs:** Many of the upland erosion management plans are in place or soon to be; such as the Middle Creek restoration area for sediment settling, new project erosion controls, and studies to locate the highest erosion inputs [stream sediment fingerprinting], et al. **Second lower in-lake P:** Artificially locking up the recycling P in the lake to a lower internal loading level will restore the balance of upland input and natural internal lockup and loss. This will lower the potential for dominate cyanobacteria blooms.

The pilot project will develop a cost amount for lake treatment and proposes to meaningfully partner with participant governments in the water basin including Tribes, County and City and other land users. In addition, the data will lead to estimates of successful application amounts with costs.

I strongly concur with this proposal for a pilot project.

Former BRC founding member; Former Lake County Supervisor District 3; Retired Branch Chief CDFG Watershed Habitat Technical branch. Present BRC Technical Committee Subcommittee, Professional Environmental Consultant.

Clear Lake Blue Ribbon Committee
LG Sonic Clear Lake Harmful Algal Bloom Monitoring, Prediction, and Control System

Project Title: Clear Lake Harmful Algal Bloom Monitoring, Prediction, and Control System

Project Description:

Summary of the project

Given Clear Lake's naturally eutrophic state, rising temperatures associated with climate change present managers with increasingly tight tolerances with respect to mitigating harmful algal blooms' (HABs) impacts on lake uses. HABs threats have an environmental justice valence, as key users include Tribal Nations, water treatment systems, and residents for recreational use. Also, these treatment plants usually cannot intercept cyanotoxins, placing households at risk for exposure. The CDC's One Health approach to HABs also makes it clear that events pose a unified threat to human health as a subset of environmental health.

This proposal is designed to pilot and show the effectiveness of LG Sonic's MPC-Buoy to control and mitigate HAB's in designated areas of Clear Lake. Remote sensing studies have indicated that HAB in Clear Lake originate from certain hotspot areas within the lake, from where they spread into the rest of the water surface. By preventing formation of algae in some of these hotspots, this project aims to reduce and mitigate the effect of HABs in Clear Lake. The algal blooms are targeted using specific ultrasonic frequencies that control algal growth effectively without negative side effects to the environment.

Background

The MPC-Buoy system was developed in 2012 by LG Sonic based in the Netherlands. LG Sonic US is based in Pennsylvania and supplies and services all North America. The MPC-Buoy has been deployed of 50+ countries and in 20+ US States. The first US install was in 2014 by American Water in New Jersey. Since that time, American Water has installed systems at 8 reservoirs in the US, in addition, over 50 additional systems have been installed in US lakes and reservoirs. These range from 16 ha [40 ac.] (1 buoy) to 120+ ha [300+ ac.] (12 buoys) around the US. Our largest international deployment was in the Dominican Republic in a lake/reservoir of 688 ha [1,700 ac.] (46 buoy system).

The MPC-Buoy is solar powered with no reliance on an outside power source. This not only creates an economical long-term algal control strategy but also flexibility for system modifications if or when conditions may change. Also, an integral part of the MPC-Buoy is its monitoring system. A critical part of the system is monitoring water quality and its system to optimize treatment based on current water conditions. As a secondary benefit, this data will allow local water professionals to track improvement

in water quality and algal concentrations. The MPC-Buoy can also be integrated with other water quality monitoring options such as real-time phosphorous monitoring, a vertical profiler, and weather stations. These ad-ons allow an even more powerful interpretation of the water conditions and better optimization of the ultrasonic treatment and are also incorporated in this proposed pilot.

When a waterbody suffers from algal blooms, managers often seek to reduce phosphate, which is the key nutrient that algae and cyanobacteria consume to grow. However, besides phosphate, light is also a critical resource for all phytoplankton. The MPC-Buoy uses ultrasonic waves to form a continuous pressure cycle around the algal cells. This affects their buoyancy regulation, which does not allow them to obtain sufficient buoyancy to remain the area where photosynthetically active radiation is high enough for them to bloom. This approach excels because it retains vibrant primary producer populations and allows lakes to reach stable chemical equilibria on their own without the shocks observed with external chemical treatments.

Through the implementation of algorithms, LG Sonic uses machine learning to predict environmental challenges such as algal blooms. LG Sonic developed and implemented these algorithms, and they function at the core of their technology. Users can visualize the data and models through an online platform, called the MPC-View. Finally, the systems installed by LG Sonic control algal bloom formation, which will be of key importance to safeguard water quality.

Integrated algorithms effectively adapt ultrasonic programs to the present algae type, while other algorithms provide prediction of algal blooms up to 10-days ahead. The algorithms are based on a Machine Learning (ML) model that applies deep learning technique known as N-BEATS. Using advanced tools for data analysis and artificial intelligence, we can model growth of trends in chlorophyll-a and phycocyanin up to 10 days ahead. In addition to using the data from our in-situ sensors, users can extrapolate data from remote sensing images to develop predictions over the entire surface of the waterbody.

The MPC-View software visualizes the water quality data. The software provides insight into the water quality, algae trends, and the progress of the ultrasonic treatment. Furthermore, the software displays technical parameters, such as the status of the ultrasonic transmitters, signal strength, and battery strength. Alarms can be set on the MPC-View for certain thresholds on parameters. These same alarms will also trigger automatic responses of the system, such as the changes of the ultrasonic treatment for algae control, alert an operator, or a prompt staff to collect a laboratory sample.

Project description

LG Sonic conducted a remote sensing analysis to determine the areas with the highest chlorophyll-a and phycocyanin concentrations within Clear Lake at different times in the year. We calculated the median chlorophyll-a (Figure 1) and phycocyanin (Figure 2) concentrations for the combined summers of 2021 and 2022, shown in the following images. We chose the median as a statistical measure, as it represents the most typical conditions on Clear Lake for the selected period. We identified six hotspot areas within the lake, labeled 1-6 in Figure 3. Figure 4 illustrates major water users' adjacency to these hotspots.

Treatment Area 6 with Vertical Profiling and Phosphate Monitoring

18 MPC-Buoys, additional – 2 MPC-Buoys with Vertical profilers, 2 buoys with phosphate sensors and consumables.

To really understand why certain problems such as algal blooms occur in lakes and reservoirs, it is beneficial to measure the water quality at different depths and in brief time intervals. Although staff manually sample at different depths in a water column, the limited interval of sampling (weeks or even months) makes it easy to miss peak events that are important for correct interpretation.

Our vertical profiler can be pre-set to take samples from a wide range of depths within a water body and measure key water parameters in real-time. The system transmits data through 4G, radio, or satellite to the MPC-View online software. The profiler measures up to a maximum depth of 100 m at 50 cm intervals. The vertical profiler monitors in-situ water quality parameters and wet-chemistry parameters. Expected outcomes include a better understanding of thermoclines, hypoxic/anoxic zones, and benthic bloom dynamics.

The unique wet chemistry sensor developed by LG Sonic, in collaboration with Dublin City University monitors physicochemical parameters in the water that staff conventionally only measured in the laboratory. The lab-on-chip technology truly functions as a floating, self-calibration, real-time laboratory that can monitor parameters at different depths. The orthophosphate as phosphorus sensor assesses the eutrophic status of the lake, identifies release of legacy nutrients from the sediment of the lake, and identifies discharge events at the surface of the lake.

Projected Budget	
Task	USD ($)
1: Education and Outreach	15,000
2: Planning and Permitting	20,000
3: MPC-Buoy purchase & Install	939,200
4: Monitoring & Maintenance	567,600
5: Final Reporting	25,000
Overall Budget Request	1,566,800

After 3 years, buoys are to be maintained by owners. Services supplied by LG Sonic US, as needed, or requested by the owner.

For budgeting purposes after year 3:

1) Annual calibration, IAC, and data managements costs - $32,800
2) 4 Service visits by LG Sonic US – If needed or requested - $48,000
3) Parts accrual - $30,000

MPC-Buoy Lifespan is estimated at 12-15 years.

Clear Lake managers, rightsholders, and stakeholders will determine project success. Nevertheless, quality-based limits could include chlorophyll-a of 60 µg/L, phycocyanin of 30 µg/L, and pH of 8.5.

It is important to note that eutrophic lakes may require multi-year treatment campaigns to attain stable and desirable parameter values. It may also be desirable to assess small water treatment system finished water's compliance with federal and state cyanotoxin exposure limits.

LG Sonic US and approved subcontractors will design and construct the MPC-Buoy system. Trusted third parties, including Tribal Nations, SWAMP, and academic partners should manage any required monitoring components. Project managers should also coordinate with CEDEN to coordinate data archive and access.

Project Timeline:

- **Month 1-3:** Planning and permitting, CEQA, and outreach
- **Month 4-6:** Outreach and engagement, project construction, and baseline monitoring
- **Month 7-8:** Buoy Installation and deployment
- **Month 9-12, year 2-3:** System run – treatment and monitoring
- **Year 4:** Final report preparation

Contact Information:

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- EJ Neafsey, PhD – Chief Water Scientist 860.849.8560 ej.neafsey@lgsonic.com
- William Fox – Lake County Program Coordinator 707.530.5014 william.fox@lakecountyca.gov

Additional Information:

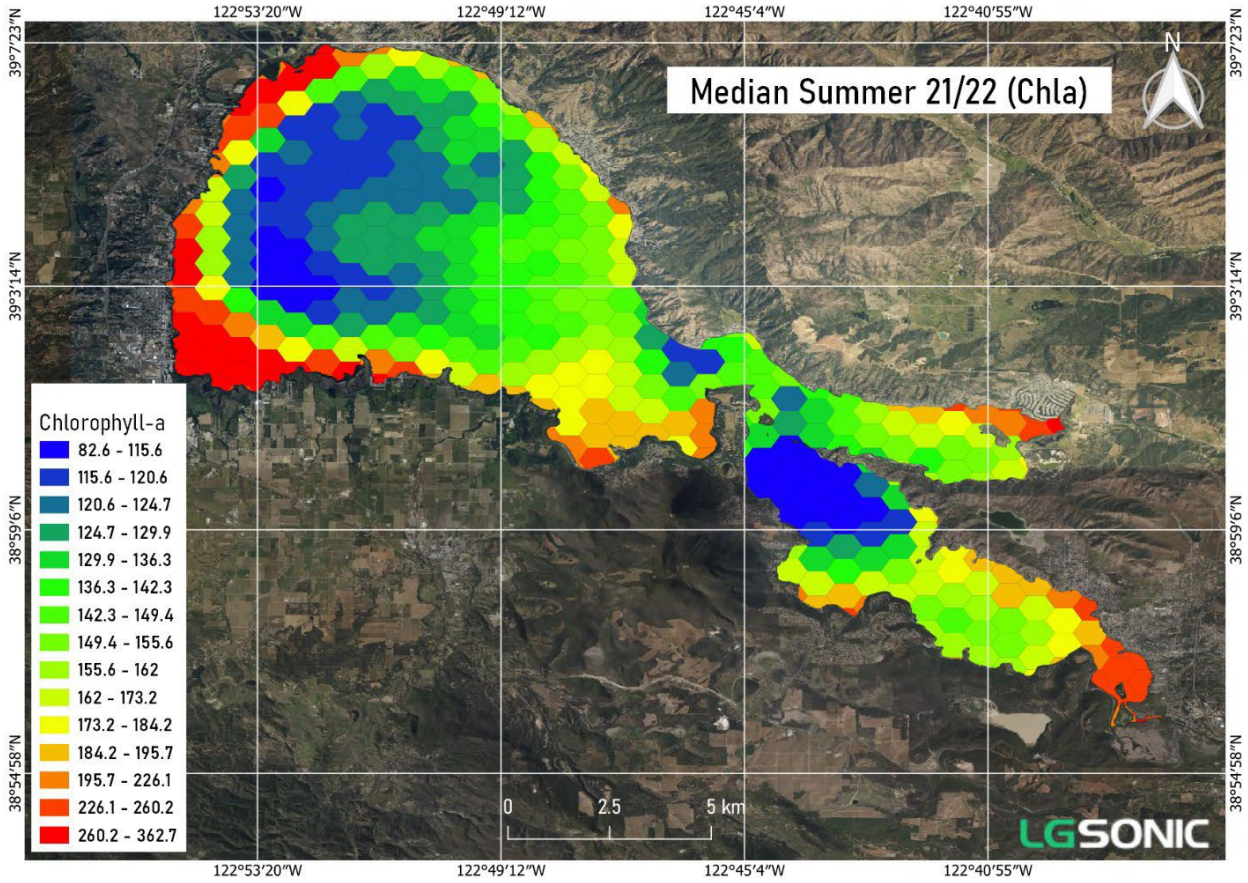

Figure 1 - Clear Lake - Chlorophyll-a (Median - Summer 2021/2022)

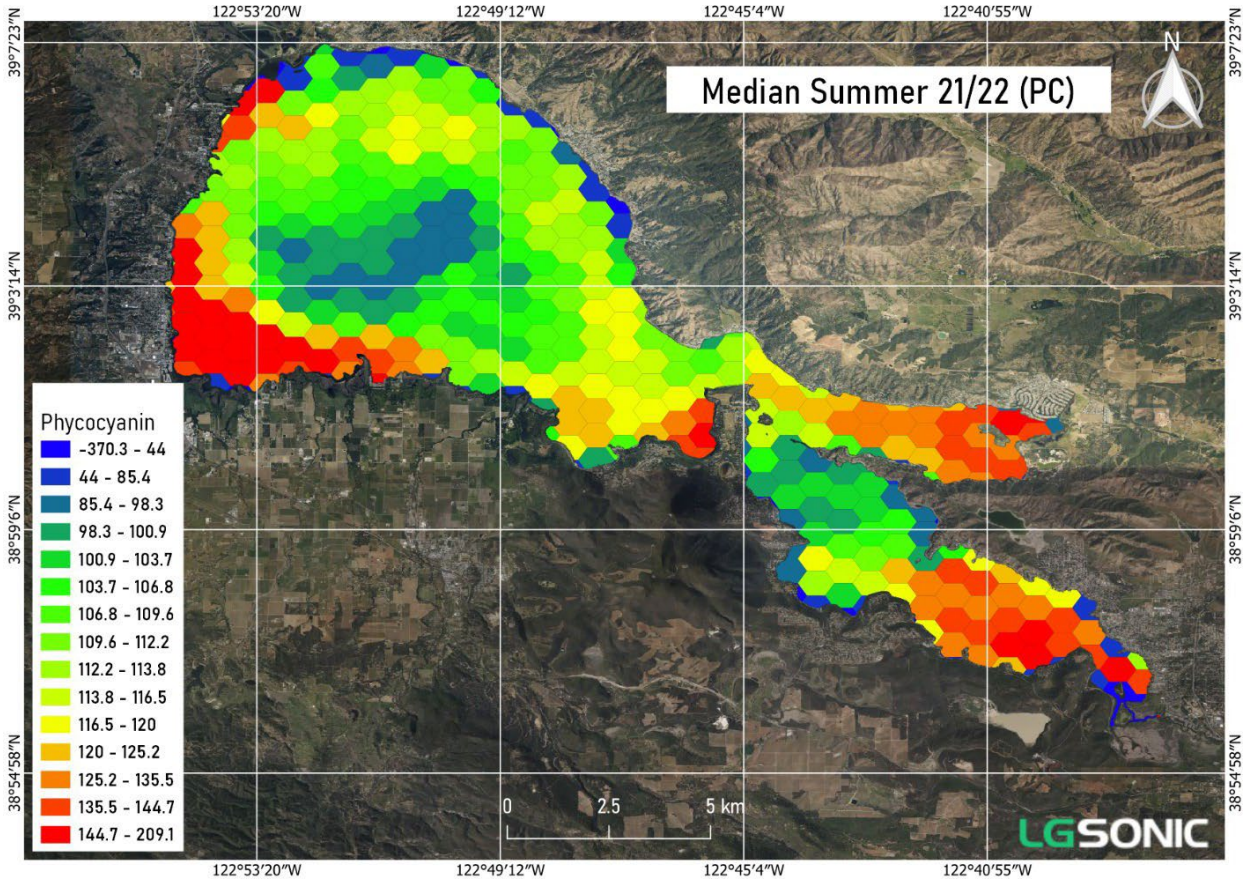

Figure 2- Clear Lake - Phycocyanin (Median - Summer 2021/2022)

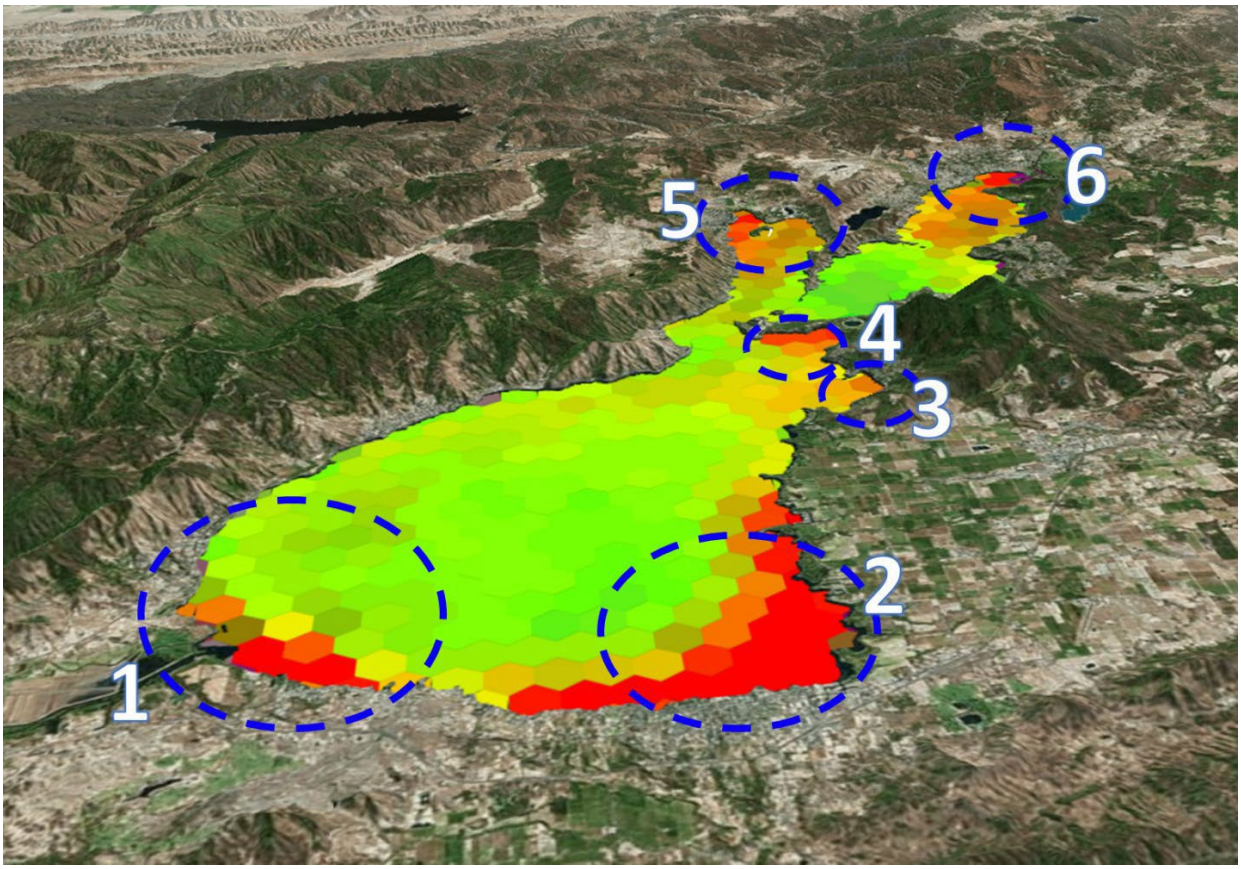

Figure 3 - Clear Lake Bloom Hotspots

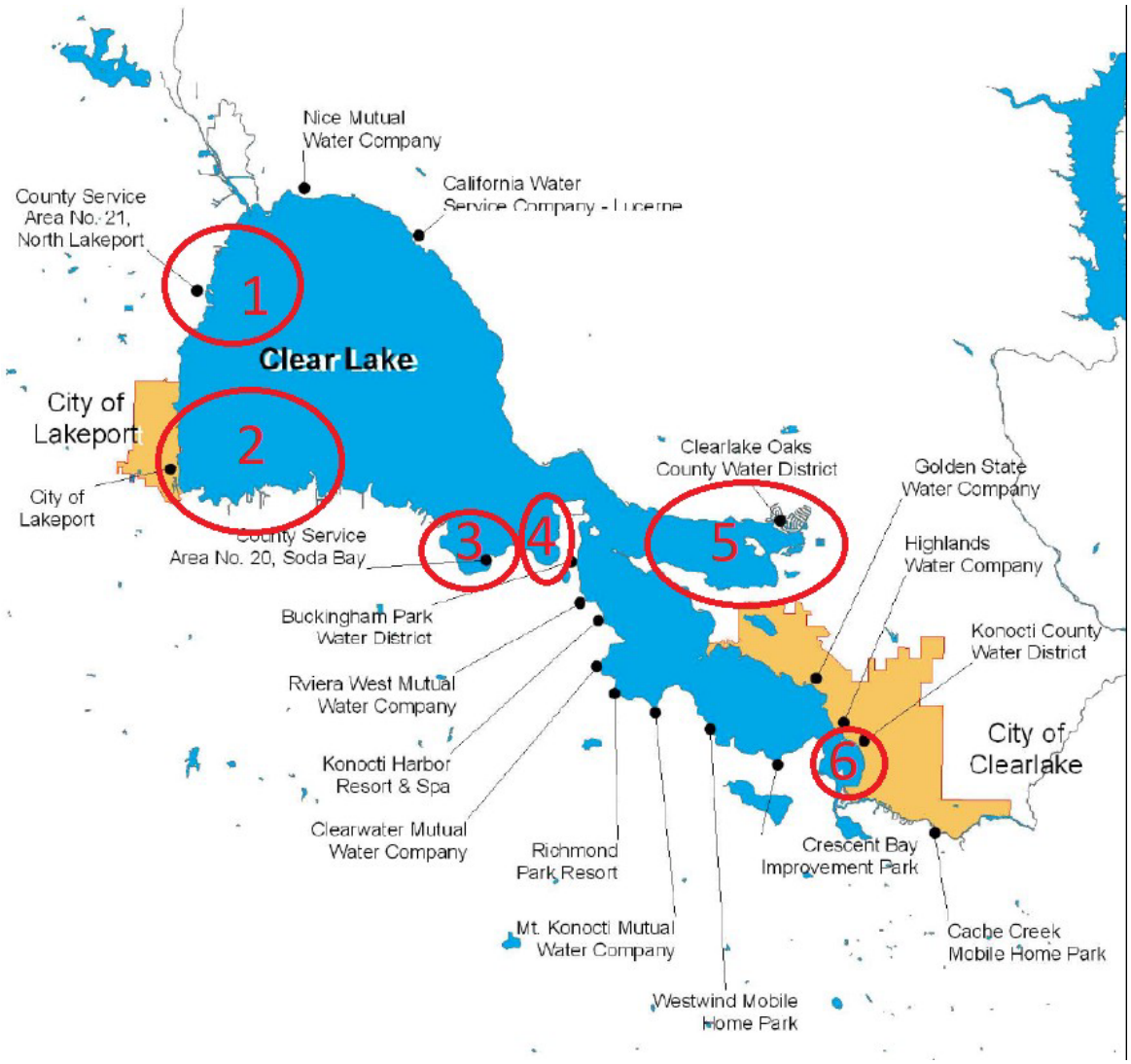

Figure 4 - Clear Lake Bloom Hotspots and Major Water Users

Clear Lake Blue Ribbon Committee

AECOM/Central Valley Regional Water Quality Control Board: Optimization of Algae Harvesting Technology To Prevent CyanoHABs In Clear Lake

March 2023

Project Sponsor: Central Valley Regional Water Quality Control Board

Project Participants:

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Project Description:

1. Background

Clear Lake provides a variety of beneficial uses for recreation, agricultural irrigation, drinking water, and habitat for fish and wildlife. Most notably, Clear Lake is particularly important for the California Native American Tribes and provides Tribal Beneficial Uses, that include uses of the water that support tribal cultural, spiritual, and ceremonial uses and Tribal subsistence fishing. Cyanobacteria cause a variety of issues for Clear Lake including decreased water quality, increased strain on water treatment facilities, and the expansion of anoxic events and noxious smells. Clear Lake has also experienced massive

cyanobacterial harmful algal blooms (cyanoHABs) associated with extreme concentrations of cyanotoxins (Mioni et al., 2011; Winder et al., 2010, Smith et al., submitted) that pose significant health risks. Due to the adverse impacts to beneficial uses by cyanoHABs, Clear Lake was added to the Clean Water Act Section 303(d) List of Impaired Water Bodies due to nutrient impairments. More recently, Clear Lake has also been listed on the 303(d) list due to impairments caused by microcystins (one type of cyanotoxin).

The Central Valley Regional Water Quality Control Board (CVRWQCB) adopted a control program that included a total daily maximum load (TMDL) and Control Program to limit the amount of external phosphorus entering the lake (CVRWQCB, 2007; Webber, 2006). The TMDL targeted a phosphorus load reduction of 87,100 kg per year, representing a roughly 40% reduction in average annual loading. Additionally, the TMDL identified a target chlorophyll *a* concentration of 73 µg/L for the lake. To date, some dischargers have met the load allocations of the TMDL while others continue to work toward the reduced phosphorus load allocations (CVRWQCB, 2021). In more recent years, focus has turned to the role of internal loading of nutrients (i.e., recycling of nutrients already present in the lake) as the cause for recurrent cyanoHABs in the lake, potentially exacerbated by climate change and drought. One very recent review of the ecology of Clear Lake, whose authors include some of the principal investigators on this proposal, has identified internal loading as the major source of nutrients now driving cyanobacterial blooms in the lake (Smith et al., submitted). Another recent study reached a similar conclusion (Framestead et al., 2020). At the time that the TMDL and Control Program was developed, phosphorus was the primary nutrient attributed to controlling cyanobacterial blooms in freshwater systems. Since then, studies have showed that nitrogen as well as phosphorus affect cyanobacterial blooms, and both nitrogen and phosphorus need to be included in water quality management strategies (Conley et al., 2009; Paerl and Otten, 2013; Scott and McCarthy, 2010, Paerl et al., 2018). Nonetheless, focus on phosphorus is appropriate since nitrogen fixation and denitrification can alter nitrogen availability in the lake, while phosphorus is immutable. The CVRWQCB has committed to revision of the TMDL and Control Program based on current scientific understandings to address both nitrogen and phosphorus inputs. However, addressing the internal nutrient loads in the lake will be challenging since TMDLs are a very structured regulatory tool for discharges (i.e., external loads). Therefore, innovative technologies and alternative management solutions will need to be identified to address **the legacy internal nutrients in Clear Lake**. One such technology is the **AECOM Algae Harvester that specifically targets the removal of internal nutrients**.

Due to the extensive cyanoHABs in Clear Lake, two Tribal Nations, the Big Valley Band of Pomo Indians and the Elem Indian Colony, developed the Clear Lake Cyanobacteria Monitoring Program (CLCMP: https://www.bvrancheria.com/clearlakecyanotoxins) in 2014 which includes water quality parameters along with cyanobacterial-specific parameters such as cyanotoxins, phycocyanin, and cyanobacterial species identifications. Cyanotoxins were first documented in Clear Lake in 2011 (Mioni et al., 2011) and have been routinely detected by the CLCMP since 2014, sometimes at extreme high concentrations. The regular monitoring data provided by CLCMP, a program now largely directed by the Big Valley Band of Pomo Indians, has shown that microcystins are detected in most years and concentrations exceeded California recreational health thresholds, including the highest 'Danger' threshold in six of the seven years of data (2014 – 2020) (Smith et al., submitted), a pattern that continues to the present. The highest concentrations have occurred in Oaks and Lower Arms of the lake. These cyanoHABs have been associated with extremely high concentrations of microcystins, reaching up to 16,920 µg/L (Smith et al.,

submitted), which is more than 840 times, 2,800 times and 20,000 times the California 'Danger' (20 µg/L), 'Warning' (6 µg/L) and 'Caution' (0.8 µg/L) recreational guidelines, respectively (CCHAB, 2016). Anatoxin-a concentrations have been observed more sporadically than microcystins, in part due to more sporadic analyses conducted for anatoxin-a, but positive detections have been reported in approximately half of the years since measurements began, with most detections in Oaks and Lower Arms. Anatoxin-a concentrations exceeded the California recreational health thresholds (detection of anatoxin-a constitutes a 'Caution' level) in most years in which anatoxin-a was analyzed.

2. Project Purpose and Goals

There are three primary project goals for this study:

1. **An algae harvester with Hydronucleation Flotation Technology (HFT) will be operated to remove algal and cyanobacterial biomass, nutrients (phosphorus and nitrogen) and cyanotoxins from the lake.** The project will showcase how the algae harvester physically and efficiently removes algae/cyanobacteria, and the nutrients and cyanotoxins that they contain, from the water. The clarified water returned to the lake will be dramatically cleaner and highly oxygenated providing direct benefits to Clear Lake. The project will be situated in the City of Clearlake (**location shown in Figure 1; letter of support attached to this proposal as an Appendix**) because it is routinely an area of extreme blooms. The project will demonstrate how the innovative HFT Algae Harvester can be an effective and environmentally safe management solution to address nutrient and cyanoHAB impairments in Clear Lake, and specifically *to address the primary driver of toxic cyanobacterial blooms in the lake at this time,* ***internal nutrient loads***. Information gained from the study will support the development of an optimal AECOM algae harvesting treatment plan for Clear Lake to mitigate cyanoHABs, reduce internal nutrient sources, and return the lake to a state prior to the appearance of toxic and extensive cyanobacterial blooms.

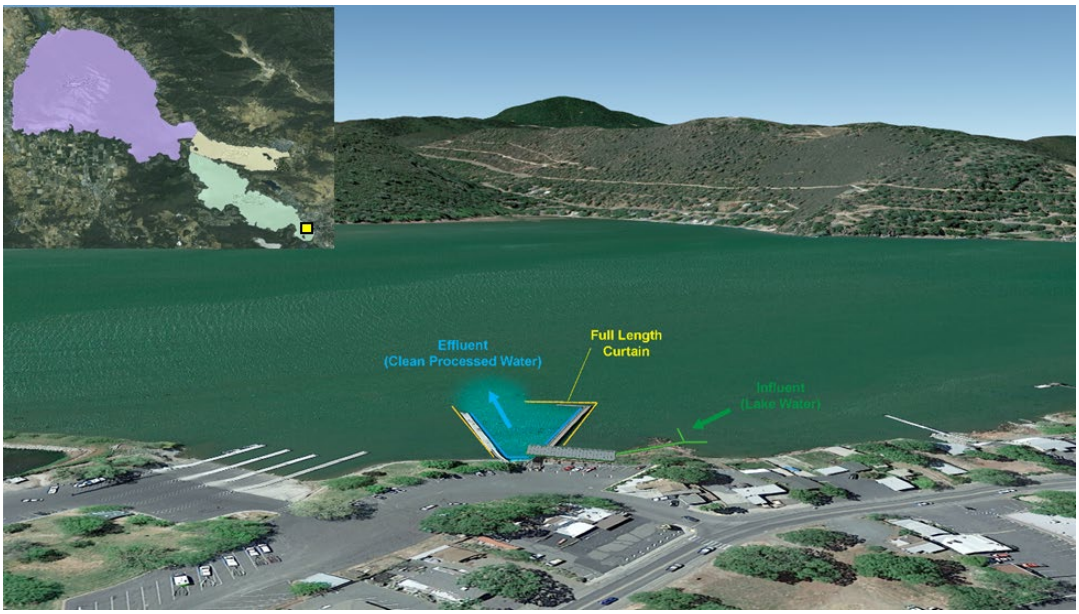

Figure 1. Proposed location and illustration algae harvester deployment.

The project will generate quantitative information on the removal efficiencies for nitrogen, phosphorus, chlorophyll-a, and cyanotoxins (focusing on microcystins, as the major concern in the lake at this time) by comparing their concentrations in water flowing into and out of the algae harvester. Monitoring for pertinent chemical/physical parameters will also be conducted in Clear Lake in the immediate vicinity of the harvester outfall, and at various distances around and away from the harvester in Lower Arm. Monitoring will be carried out in coordination and collaboration with existing monitoring efforts presently being conducted by the Clear Lake Cyanobacteria Monitoring Program (CLCMP) throughout the lake, and with two nearby drinking water intakes (Konocti Water Company and Highland Water Company, (letters of support to be provided) in collaboration with Kennedy Environmental, *in an effort to assess the ability of the harvester's activities to affect water quality around the operation*. The effectiveness of the harvester for reducing algal/cyanobacterial biomass, chlorophyll, nutrient and toxin concentrations will be examined by returning water processed through the harvester to a partially enclosed region of Clear Lake (see description of the study area below, and **Figure 1**). The effectiveness of the pilot-scale demonstration will be independently verified in the partially enclosed region of the lake receiving processed lake water, and at various distances from the enclosure by Aquatic Ecotechnologies, LLC in collaboration with the CVRWQCB.

2. **Hydrothermal Liquefaction Technology (HTL) will be used to transform algal/cyanobacterial biomass removed from lake water by the algae harvester into 'clean', carbon-neutral crude oil**. This aspect of the project will demonstrate the potential to create carbon-neutral crude oil from the biomass that is recovered from Clear Lake by algae harvesting, thus creating a sustainable, closed-loop system that can help restore the water quality in Clear Lake without creating unwanted and costly waste material.

3. **Based on the project results, a treatment plan will be developed using algae harvesting to reduce internal nutrients thereby directly addressing and reducing cyanoHABs in Clear Lake.** The results will be used to develop a treatment plan and associated costs for implementation of a scaled-up algae harvester system to address water quality goals for Clear Lake. An estimation of this has been provided below, as requested by the BRC. Revision of the Clear Lake Nutrient Control Program could include implementation of AECOM's system as a long-term implementation activity to address HAB impairments and work towards reducing internal nutrients in Clear Lake. The AECOM pilot demonstration will provide information on the potential nutrient removal that can be used to determine possible nutrient reduction goals from a scaled-up version of the AECOM technology. The scaled-up AECOM system could potentially be included in the Central Valley Water Board's revised Clear Lake Control Program as part of the implementation plan.

Several questions were raised by the BRC and the BRC Technical Advisory Subcommittee regarding the proposed project during our presentations. These questions were far in excess of questions that have been raised for any other HAB mitigation technology or approaches that have been approved by the BRC, or proposed for application in the lake. Nonetheless, we are pleased to be able to directly address these questions. We do so here before describing the technology in more detail below:

1) *To what nutrient state would the technology attempt to return Clear Lake?* It is unreasonable and unnecessary to return Clear Lake to a pre-industrial state to prevent HABs. It has been a

eutrophic lake for ages but, importantly, *not* a cyanobacterial-dominated lake. Our reasoning here is based on our very recently submitted review paper of the nutrient status and HAB situation for the lake (Smith et al., submitted). In that study, all historical information on total phosphorus concentrations (among other parameters) in Clear Lake were summarized going back to 1965 (**Figure 2**). Note that there is a gap in the data between 1991 and 1998 when no data were collected creating a natural 'break' in the data. We reasoned that, since toxic cyanobacterial blooms have been a problem in Clear Lake only relatively recently (the last decade or so), phosphorus levels in the lake were not sufficiently high to promote the dominance and toxicity of cyanobacteria in the lake until relatively recently, at which point it passed a 'tipping point' into a different stable ecological state dominated by cyanobacterial blooms. Indeed, publications from the 1960s reported that abundances of cyanobacteria were extremely low in the lake at that time, and only a few species were observed (compared to a high diversity of species that are now present). Therefore, we used the natural break in the data (pre-1992 vs. post-1997) to determine average total phosphorus concentration in the lake before and after the data gap. Based on those two averages, we developed a target goal for reducing total phosphorus from the post-1997 average (0.16 mg/L; number of data points = 1,021) to the pre-1992 average (0.12 mg/L; number of data points = 1,922). Given this information, we hypothesize that a reduction of 0.04 mg/L would be sufficient to return the lake to pre-toxic-bloom conditions (i.e., a phosphorus concentration will not promote dominance and toxin production by cyanobacteria). For the whole lake, that is equivalent to 56,800 kg of phosphorus. For simplicity in this 'first order estimation', our calculations do not take into account external sources of phosphorus entering the lake, or natural discharges of phosphorus in water leaving the lake, or burial deep in the sediments. We also do not take into account phosphorus in the sediments that might become mobilized into the water column. However, these caveats aside, our calculations have allowed us to place rough bounds on the harvesting effort required to remove an amount of phosphorus required to bring toxic blooms in the lake back under control.

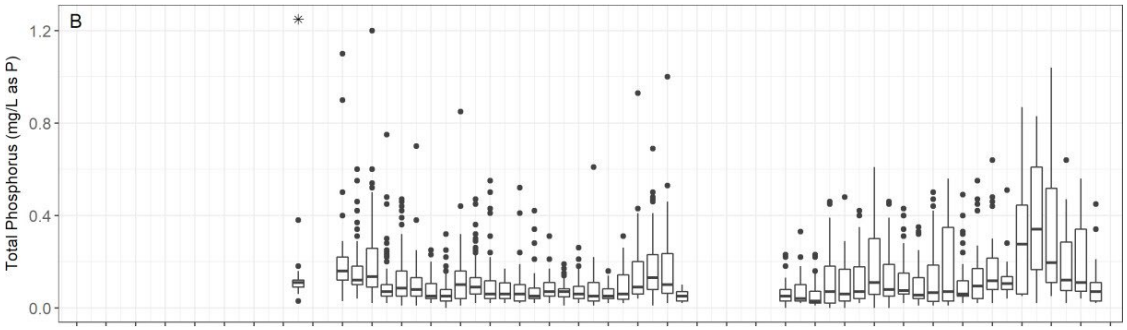

Figure 2. Box plots of the historic record of total phosphorus measurements in Clear Lake between 1965 and 2019. Horizontal bars within boxes indicate median annual values, vertical extent of boxes show upper and lower quartiles of values, dots indicate outliers. Asterisks indicate concentrations larger than 1.25 mg/L as P. From Smith, et al. (submitted).

2) *Given this goal (our target phosphorus reduction, calculated above) how long will the treatment take, and how many harvesters?* Our estimate (above) on the amount of phosphorus that needs to be removed from the lake and the volume of the lake guide various options for how lake

treatment might be enacted in a full-scale application of the algae harvester. First, we anticipate the treatment would focus on those regions of the lake where and when blooms predominate and reach extremely high levels. This approach will maximize the effort of the harvesters and will significantly increase the amount of material removed from the lake per unit time. Concentrating on the down-wind ends of the lake where biomass can be 10-20X greater than other regions of the lake, we anticipate removal in excess of 5 kg P per harvester per day. For the removal of 56,800 kg of phosphorus, this equates to 4-6 units working for 10-15 years if run for half the year (i.e. during bloom periods to maximize biomass removal). This estimate does not take into account improvements in technology (e.g., automation and further efficiencies to improve removal rate), now in design. Furthermore, algae harvesting provides multiple additional water quality benefits including oxygenation of the treated water and removal of organic matter that would reduce the potential for anoxia and nutrient release from sediments.

3) *What would the projected costs for such a project be?* The harvester technology has advanced rapidly in recent years, and will continue to advance. It is anticipated that multiple harvesters could be deployed for a reduced period of time, or fewer harvesters for a longer period of time, until the phosphorus removal goal is reached (i.e., the occurrence of toxic blooms subsides). Additionally, the system could be designed to maximize water quality benefits within targeted areas of the lake during treatment. For example, 5 harvesters can treat about 1 billion gallons of water in six months, equivalent to about half the volume of water within an area of 260 to 390 acres depending on water depth at the base of the Lower Arm (refer to **Figure 3** for illustration). In this design, the area treated would be diluted by 50% with high quality water that has low phosphorus (~0.01 mg/L). The ultimate design of a treatment system is, obviously, an exceptionally difficult endpoint to predict accurately because of the many treatment design options and lake variables that cannot be taken into account (future land use in the basin; changes in the TMDLs; wildlife impacts; droughts or flooding, etc). *Better bracketing this estimation is one immediate goal of our project.* Nonetheless using a ballpark figure of $1.5M/harvester, major infrastructures costs would be on the order of $9M (for 6 harvesters).

Figure 3. Estimated lake areas treated with five 1-MGD algae harvesters.

4) *What will be the impact of algae harvesting on the Clear Lake Hitch?* Our project will not significantly affect the Hitch because water will be removed from the lake away from the shore and at a highly HAB-impacted location that is generally unacceptable to fish. However, discharge of water from the harvester will create a modest-sized, body of water with greatly improved quality, which might positively affect juvenile fish near the shore (**Figure 1**). Most significantly, full-scale application of algae harvesters would dramatically improve water quality nearshore where juvenile Hitch congregate, and generally around the locations of harvester discharges.

3. What does 'success' look like for this pilot study?

Our project will demonstrate the potential for the AECOM harvester to remove particulate biomass, nutrients and toxins, and return dramatically cleaner water to the lake. Success of the demonstration study will be judged by the ability of the HFT AECOM algae harvesting treatment to reduce algal biomass, chlorophyll-a, particulate phosphorus, particulate nitrogen, and cyanotoxins (microcystins) by 80-90% between in the inflow water (coming from Clear Lake during bloom conditions) and outflow water (water exiting the harvester being returned to the lake during normal harvester operations). AECOM will conduct measurements on the water flowing into and out of the harvester for all parameters. Additionally, success will be judged through *independent monitoring* (organized through Aquatic Ecotechnologies, LLC, involving collaboration with local Tribes and drinking water purveyors and the CVRWQCB) to determine the impact on water quality in the immediate vicinity of the water being returned to the lake from the harvester. Data generated through the monitoring effort will be summarized and made publicly available by Aquatic Ecotechnologies, and represents a *fundamental component of this project that will ensure independent corroboration of findings from the study*.

Information on "clean" carbon-neutral crude oil produced by HLT will be provided but will not be considered towards the overall success of removing algal/cyanobacterial biomass and nutrients.

4. Who will conduct the work?

a. **AECOM:** Daniel Levy and Tammy Karst-Riddoch (AECOM) will take the lead on all aspects of setup and performance of the HFT Algae Harvester system, and Hydrothermal Liquefaction Technology (HTL), inflow and outflow systems for the harvester, and setup of the curtain system into which the outflow from the harvester will be directed. Arrangments for site location and facilities will be facilitated by the City of Clearlake (see letter of support) AECOM will also conduct monitoring of all parameters (as detailed below) in the water flowing into the harvester and exiting the harvester and reentering the lake (monitoring performed usually daily). Report writing will be conducted in conjunction with Aquatic Ecotechnologies, LLC.

b. Aquatic EcoTechnologies: David Caron (Aquatic Ecotechnologies, LLC; AET) will provide overall design and oversight of the project, independent monitoring of parameters (as outlined above and detailed below) in the region of the lake from which water is drawn into the harvester, as well as the

region of the lake receiving water flowing out of the harvester. Occasional sampling/monitoring (7 times during the pilot study) will be conducted on intake and outflow water, and water nearby the location of the harvester, in order to provide cross-checks with AECOM measurements of influent and effluent, and document improvements of water quality in the lake at various distances from the harvester outflow. Additionally, Caron will provide phytoplankton community analysis on inflow water and water in the lake nearby the harvester to determine the composition of the community during the study performance. He will lead the data summary for all monitoring results, analyses and report writing, which will be conducted in conjunction with all parties.

c. **CLCMP and Drinking Water Purveyors:** Sarah Ryan (Big Valley Band of Pomo Indians) and Karola Kennedy (Kennedy Environmental) will collaborate on monitoring. Ryan will coordinate the efforts of the CLCMP which will be expanded to include monitoring locations in the general vicinity of the demonstration (constituting cross-checks with monitoring performed by AET and AECOM. Kennedy will coordinate monitoring with two of the drinking water conveyors in the vicinity of the demonstration. Ryan and Kennedy will participate fully in report writing, led by AET.

d. **Central Valley Regional Water Quality Control Board:** *The Water Board will not receive funds from this award.* Conversely, Meredith Howard (CVRWQCB) will provide in-kind matching funds in the form of personnel to assist in monitoring activities, permitting and report writing, led by AET.

e. **City of Clearlake:** The City has agreed to host the demonstration, and is eager to test technology that shows promise for improving water quality in the Lower Arm of Clear Lake. The City has performed a preliminary assessment for siting the harvester, and providing power. They are confident that they can host the demonstration.

5. Approach and Specifics of Demonstration

a. AECOM Technology and Demonstration

AECOM's innovative HFT algae harvester physically removes suspended algae and other solids along with associated nutrients and algal toxins from impacted waterways (**Figure 4**).

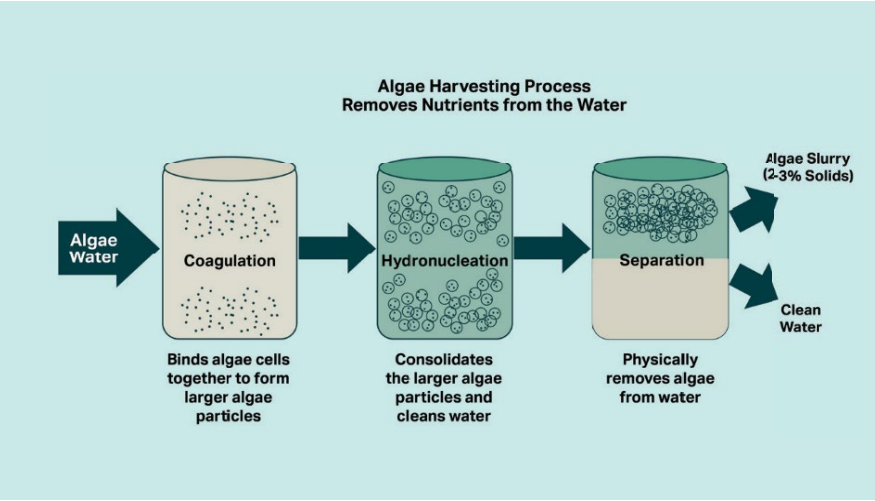

Figure 4. Illustration of the algae/cyanobacteria harvesting process.

The process begins by pumping water from Clear Lake to a collection tank on the land-based harvesting system where the algae and other solids are coagulated to form larger particles. The next step is hydronucleation, where nanobubbles are used to float the coagulated algae to the surface of the tank forming a "float blanket". A separation step then physically removes the algae by skimming the float blanket from the surface of the water to an algae collection tank. Clean water is discharged back into Clear Lake (as effluent from the algae harvester) and the recovered algae is further processed, including dewatering and HTL demonstration which transforms the biomass into renewable products such as biofuel and biofertilizer. AECOM will locate the HFT algae harvester at a site located at the eastern end of Lower Arm, Clear Lake (a site known for its massive accumulations of cyanobacteria). **Figure 1** illustrates the proposed site for where and how the HFT algae harvester would be deployed at Clear Lake.

The study will be conducted in the mid-summer to early fall-time frame when blooms tend to be highly developed. AECOM will mobilize a 1-million gallon per day (MGD) design capacity HFT algae harvester to the selected site on Clear Lake along with all the necessary equipment and personnel to conduct the research work. Water will be pumped from Clear Lake and piped to the algae harvester for liquid/solid separation by HFT. The clarified water will be continuously returned to the lake within an enclosed area. A turbidity curtain will be installed around the 0.5 acre area between the pier and boat ramp to section off a clarified zone. The purpose of this clarified zone is to more accurately model the lake's restoration needs and to demonstrate, at a small scale, the effectiveness of the HFT algae harvester, visually and through monitoring activities.

The separated algae will be skimmed to a slurry collection tank. Some slurry will be dewatered, and processed by HTL to demonstrate the potential to create carbon-neutral biocrude oil, destroy toxins present in the slurry, and reduce costs associated with waste disposal. The remaining algae slurry will be disposed at a local landfill to minimize costs of this project.

Algae harvesting will be performed over a three-week period (exclusive of two-week setup and one-week breakdown) to evaluate the efficacy of the treatment system to remove algae and nutrients. The algae harvester is expected to be capable of processing water at a rate of between 500 gallons per minute (GPM) and 700 GPM (1 MGD) and will be operated at a flow rate that will optimize performance given the characteristics of the surface water quality in the lake and its response to treatment, or as governing permits allow. The water treated by algae harvesting will be assessed (i.e., comparison of characteristics before and after processing) to determine the nutrient removal efficiencies of the treatment. The recovered algae slurry will be evaluated to identify potential reuse options.

b. Monitoring

i. Influent/Effluent Monitoring of the HFT harvester

Monitoring of influent (raw water from Clear Lake entering the HFT algae harvester) and effluent (treated water before it is discharged back to Clear Lake) will be conducted throughout the project, primarily by AECOM. **These data will provide a direct test for the success of the HFT algae harvester to physically remove total phosphorus, total nitrogen, and microcystins from Clear Lake**. Additional parameters will also be collected by AECOM to evaluate overall performance of the harvester, and to provide information on safety of the operation for workers and the environment (**Table 1**). The analytes include measures of algae, solids, nutrients and algal toxins that will be used to evaluate system removal

performance. Additional parameters are included to evaluate the quality of the treated water for the protection of aquatic life and to assess recovery of coagulant used in the process. Key analytes will be monitored daily during operations and other supporting analytes will be monitored less frequently.

The HFT algae harvester is also equipped with water quality monitoring sondes to continuously measure field parameters in the influent and effluent every 15 minutes during operation. The field parameters logged include temperature, pH, turbidity, conductivity, dissolved oxygen, chlorophyll-a (by fluorometry) and phycocyanin (by fluorometry).

Composite grab samples of the recovered algae slurry, dewatering filtrate and dewatered slurry (algae cake) will also be analyzed for key analytes listed in **Table 1**. These data will provide the information necessary to characterize the recovered algae biomass for its potential transformation to valued products (biofertilizer and biofuel).

Air monitoring will be conducted to assess potential worker exposure to airborne algal toxins including total microcystins/nodularins and endotoxins. The monitoring will be performed at two locations (between the shoreline and work area and near the algae harvester and dewatering unit) over two, single-day events, once during a non-operational condition and again under operational conditions.

In addition to the parameters noted above that will be measured by AECOM on the influent and effluent of the HFT harvester, AET will provide independent monitoring of the influent and effluent as part of its lake monitoring efforts (2 samples, influent and effluent, on 7 dates during the three-week demonstration). These samples will provide direct validation of AECOM's monitoring efforts, and allow extrapolation and interpretation of AECOM data with the lake monitoring (next section).

ii. Lake Monitoring

Lake monitoring will provide information on the degree to which the HFT impacts water quality during the study period in the immediate vicinity of the harvester. **It is not anticipated that the activity of the HFT will dramatically affect overall lake water quality over the short demonstration period of this study, and that will not be considered a test for success**. However, sampling in the lake in the vicinity of the demonstration study will provide an indication of the potential for the process to have an impact on algal biomass, nitrogen, phosphorus and toxins. The results will inform Goal #3 (long-term implementation activity to reduce internal nutrients and address cyanoHABs in Clear Lake).

Lake monitoring at specified locations at the eastern reaches of Lower Arm will be conducted by AET on seven dates when the harvester is running. Ten sampling sites (including the influent and effluent of the harvester, as noted above) will be conducted, at varying distances from the harvester effluent discharge into the lake. A hand-held sonde (temperature, conductivity, dissolved oxygen, pH) will be employed to gather chemical/physical parameters at each site, and grab samples will be collected for analysis of total phosphorus, total nitrogen, and microcystins (i.e., the same parameters as will be collected by AECOM).

Another key aspect of this study will be coordination with two important existing monitoring programs within Clear Lake that will be sampling throughout the lake during the study period. The budget includes categories to fund additional samples and analyses to be conducted by the CLCMP (Ryan) and Kennedy Environmental (Kennedy). The additional CLCMP sampling will focus on those regions of Lower Arm that presently have limited sampling coverage (e.g., Konocti Bay), while the Kennedy Environmental activities will provide additional (more-frequent) sampling at two nearby drinking water intakes in Lower Arm (Konocti and Highland). At least 2 of the 10 samples (per visit) collected by AET as part of their

monitoring of the lake will be collected at the same sites and times as the CLCMP and Kennedy Environmental sampling in order to facilitate direct comparison among the groups. The monitoring activities of these two entities will provide an indication of the general status of the lake during the study period, and the ability to interpret those lake-wide monitoring effects in connection with the work being conducted by AET and AECOM at and near the algae harvester study site. The monitoring data collected by all groups (AECOM, AET, CLCMP and Kennedy Environmental) will be integrated and provided in the final report.

Addendum: Addressing the Requirements of the BRC

c. Primary Requirements: Lowering of internal nutrient loads in Clear Lake directly contributes to improving the physical and biological health of the lake. As noted above, we have estimated that each 1-MGD algae harvester can remove up to 5 kg/day. Additionally, the water returned to the lake after processed through the algae harvester will be high in dissolved oxygen. That could provide an added bonus to the lake by reducing the flux of phosphorus out of the sediments and into the water column, a process that is inhibited by high dissolved oxygen. It also should be noted that this project focuses on phosphorus removal, but nitrogen, carbon, metals such as mercury and any other elements associated with the algal/cyanobacterial biomass will also be removed by the harvester (another added benefit of the process). This project constitutes a direct collaboration with the CLCMP and two water companies that operate in the lake. One vision for how a fully implemented project might be maintained is that the scaled-up AECOM system could potentially be included in the Central Valley Water Board's revised Clear Lake Control Program as part of their implementation plan, as previously noted. Another mechanism could be through the activities of water purveyors in the region, since improved water quality directly benefits their activities.

d. Secondary Requirements: Improving water quality in Clear Lake is central to supporting the tourism-based economy of the region, and will contribute directly to Lake County economy. Community engagement will be conducted through collaboration with the CLCMP and the City of Clearlake. Permitting issues appear to be minimal (if any), and CVRWQCB will provide support in this matter. *The AECOM harvester is one of an extremely limited number of technological approaches that will directly reduce internal nutrient loadings in Clear Lake*. Our recent study of the history of Clear Lake (Smith et al., submitted) confirmed that internal nutrient loads drive the recurrent toxic cyanobacterial blooms in the lake, and that harmful blooms will probably continue until the internal loads are reduced. The vast majority of approaches proposed or in operation in freshwater bodies do not reduce internal nutrients. Therefore, even if successful, blooms will return when those mitigative approaches are halted. The AECOM harvester poses the possibility of ending the return of blooms by addressing the main driver of those events in Clear Lake (internal nutrient loads). AECOM has conducted similar demonstrations in several locations across the country. AET has conducted extensive experimental studies on HAB mitigation, monitoring activities and consulting on a wide variety of freshwater and marine HAB issues locally and nationally.

e. Specific Reporting Requirements: All specific reporting requirements will be conducted in accordance with BRC expectations.

Project Timeline:

The timeline for this project will entail (1) a detailed survey and vetting of the proposed study site at the eastern end of Lower Arm (**Figure 1**), (2) pursuit of necessary permits, clearances and permissions, (3) mobilization to and setup at the study site (1 week), (4) performance of the pilot study (3 weeks), (5) breakdown and demobilization (1 week), (6) sample analysis, (6) data synthesis, (7) estimation of the effectiveness and magnitude of scale-up of the pilot study, and (8) production of the final report. A rough outline of the timing of these components is provided here:

- **The project is estimated to be completed within one year:**

  Components 1 and 2. Scoping (site survey), planning and permitting will take approximately six months. This will include, preparation of the algae harvester and supporting equipment, and acquisition of materials for the monitoring efforts. (Months 1 – 6)

  Components 3-5. The field component of the project will be conducted over a six week period; two weeks transportation and setup of the algae harvester and HTL unit, three weeks of operations, and one week of breakdown and transport off-site. All monitoring will be conducted during the study, starting just prior to HFT performance, and carrying through until after performance, as noted above. (Months 7 – 8)

  Components 6-8: Sample analyses, synthesis of data, analysis of the effectiveness of the HFT and extrapolation to Clear Lake, and report writing will be completed within four months of completed the field component. (Months 8 – 12)

Projected Budget: The budget is broken into four components according to task (AECOM for provision and operation of the HFT and HTL units; Aquatic Ecotechnologies for project planning, lake monitoring, oversight of synthesis and report writing; Clear Lake Cyanobacteria Monitoring Program for expansion of their monitoring effort at selected lake sites; Kennedy Environmental for expansion of their monitoring effort on two local drinking water intakes.

Overall cost: $1,259,920 (AECOM $1,082,000; AET $117,920; CLCMP $30,000; Kennedy $30,000)

AECOM Budget Information by Task:

Task #	Task	Subtotal
1.0	Scoping	$ 25,000
2.0	Site Reconnaissance	$ 25,000
3.0	Permitting	$ 25,000
4.0	Mobilization	$ 135,000
5.0	Setup and Shakedown (1 week)	$ 145,000
6.0	Pilot Test (3 weeks operation)	$ 550,000
7.0	Monitoring	$ 37,000
8.0	Demobilization	$ 65,000
9.0	Reporting	$ 50,000
10.0	Presentation / Media Event	$ 25,000
Total		$ 1,082,000

Aquatic EcoTechnologies, LLC budget information:

3 planning/scoping trips to Clearlake, CA

- Hotel (3 nights each @$180/night = $540/trip)
- Per diem: (4 days each @ $110/day = $440/trip)
- Travel (380 mi each @ $0.50/mile = $190/trip)

7 monitoring trips to Clearlake, CA

- Hotel (1 night each @$180/night = $180/trip)
- Per diem: (2 days each @ $110/day = $220/trip)
- Travel (380 mi each @ $0.50/mile = $190/trip)

Sensor equipment maintenance, calibration, replacement (In-Situ instrument): $2,500

Sampling bottles/filters/syringes/chemicals/disposal/other expendables: $3,500

Chlorophyll analyses: 10 samples/trip x 7 monitoring trips @$125/sample: $8,750

Total N and Total P analyses: 10 samples/trip x 7 monitoring trips @$150/sample: $10,500

Phytoplankton composition analysis: 10 samples/trip x 7 monitoring trips @$150/sample: $10,500

Toxin analyses (microcystins; anatoxins): $550/sample (2 toxins) x 35 total samples/trip: $19,250

Shipping for toxin analyses: $90/trip x 7 monitoring trips: $630 total cost

Senior Personnel Costs (@325/hr):

- Site scoping and planning trips: 9 days, 6 hrs/day: $17,350
- Monitoring trips: 1 day/trip (6 hrs), 7 trips: $13,650
- Data summary, analysis, report writing: 5 days, 6 hrs/day: $9,750
- Scoping analyses of extrapolation of pilot study to whole lake: 2 days, 6 hrs/day: $3,900
- Total Senior Personnel cost: $54,650

Total AET cost = $117,920

Clear Lake Cyanobacteria Monitoring Program:

Supplementation to existing sampling program with additional locations in Lower Arm, with the collection of parameters and information duplicating those presently collected by the CLCMP: $30,000.

Kennedy Environmental:

Supplementation to existing sampling program in conjunction with two local drinking water intakes, with the collection of parameters and information duplicating those presently collected: $30,000.

Cost Sharing Information:

- Leveraging with Tribal Programs
- Contributions from Central Valley Water Quality Control Board

Contact Information:

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Table 1. List of monitoring analytes for each matrix.

Analyte	Method	Frequency
Algae Harvesting Influent and Effluent		
Alkalinity, Total (as $CaCO_3$)	SM 2320B	Weekly (3 events)
		Daily (15 events)
Aluminum, Total and Dissolved	EPA 200.7	
Carbon, Organic, Total and Dissolved - optional	SM 5310B	
Chlorophyll-a, Total and Corrected for Pheophytin	SM 10200	
Nitrogen, Kjeldahl, Total	EPA 351.2	
Nitrogen, Nitrite plus Nitrate	EPA 353.2	
Phosphorus, Total	EPA 365.3	
Solids, Suspended	SM 2540D	
Total Microcystins/Nodularins	Ohio EPA DES 701.0 v. 2.3	
Whole Effluent Toxicity, Acute (effluent only) (1)	EPA-821-R-02-012, EPA 821-B-00-004	1 event
Whole Effluent Toxicity, Chronic (2)	EPA-821-R-02-013, EPA 821-B-00-004	2 events
Algae Slurry		
Moisture	ASTM D7582	Weekly (3 events)
Solids, Volatile	SM 2540 G	
Solids, Total	SM 2540 G	
Aluminum	EPA 3052/6010C	
Total Microcystins/Nodularins	Ohio EPA DES 701.0 v. 2.3	
Dewatering Filtrate		
Total Microcystins/Nodularins	Ohio EPA DES 701.0 v. 2.3	Biweekly (6 events)
Dewatered Algae Cake		
Moisture	D7582 Automated TGA System	Weekly (3 events)
Aluminum	EPA 3052/6010C	
CHNOPS (3)	ASTM D5373/D5291/D1552	
Fuel, Proximate (4)		
Total Microcystins/Nodularins	Ohio EPA DES 701.0 v. 2.3	

Notes:
(1) performed using *Ceriodaphnia dubia* and *Pimphales promelas*, or other test organisms as may be required by permits; (2) performed using *Ceriodaphnia dubia*, or other test organisms as may be required by permits; (3) CHNOPS = carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur; (4) Proximate = ash, fixed carbon, moisture, volatile solids, and sulfur

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Clear Lake Blue Ribbon Committee

January 18th, 2023

UC Davis TERC Early Warning System to Forecast Harmful Algal Blooms (HABs) in Clear Lake

CA Project Description

a) Background

Harmful algal blooms (HABs) caused by cyanobacteria are posing a health threat to humans, domestic animals, and wildlife at Clear Lake. They also compromise important cultural activities by tribal nations. Lake County Department of Environmental Health and Public Health and water purveyors around the lake have been facing challenges due to HABs for decades. These include the provision of safe drinking water and the high costs associated with treating lake water during HABs.

State, local and tribal organizations currently monitor the status of HABs at Clear Lake:

- Big Valley Band of Pomo Indians has been actively monitoring shorelines for HABs and cyanotoxins since 2014. During the warm season, with a frequency ranging from biweekly to monthly, they sample approximately 20 locations and provide public outreach about the harmful effects of cyanotoxins. TERC also samples six offshore locations every 6 weeks and water is tested for cyanotoxins by Big Valley Rancheria staff. Multiple platforms are making this information publicly available, such as the official Big Valley Rancheria cyanotoxins website and the Clear Lake Water Quality Portal.
- After the large HAB blooms in 2020, a collaborative project titled the "California Water: Assessment of Toxins for Community Health project (Cal-WATCH)" has placed particular emphasis on monitoring contaminated private drinking water wells around Clear Lake. Participants include the Public Health Institute (PHI), PHI's Tracking California, Big Valley Band of Pomo Indians, the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA), and the State Water Resources Control Board's Division of Drinking Water. A summary of the results from the first year of this project reveals the need to continue the efforts.

The current data and outreach provided by these organizations are key for lake residents, but they do not provide a *forecast or "early warning" of evolving HABs conditions on the lake*. While long-term solutions are still in the early research phase (e.g., Hypolimnetic Oxygenation Pilot Project in the Oaks Arm), it is possible to leverage past BRC investments in lake modeling to provide a 7-day forecast of HAB locations in Clear Lake to agencies, Tribes, water purveyors and the public. Such an early warning system allows all impacted groups to better prepare (as one would for an incoming storm), and it makes evident those areas of the lake that will not be impacted and are therefore safe for a broad range of activities.

b) Purpose

The project's goal is to create a forecast early warning system for HABs in Clear Lake. Such a system would provide Tribes, water purveyors, agencies, and the public with a lead time in responding to episodic HABs events, and help to understand the drivers of HABs in the lake to prevent their occurrence in the future, hence, improving the health of Clear Lake. The forecast lake conditions will use current lake conditions, which provides a tool to evaluate the attainment of desired goals as management actions take place.

The early warning system would comprise a one-dimensional model to provide an initial risk index and a

three-dimensional lake model to forecast HAB location for the coming seven days. Both will be “driven”

by a combination of measured meteorological data (from TERC's Clear Lake network) and National Weather Service (NWS) forecast meteorological data. Daily remote sensing data, available through the San Francisco Estuary Institute (SFEI) HABs tool (currently being upgraded and improved by our graduate student Samantha Sharp), will provide initial conditions over the entire lake (Fig. 1). Model forecasts of HAB location will be validated with the in-situ data from the cyanotoxins program of Big Valley Rancheria and Cal-WATCH and limited additional lake sensing described below, thereby ensuring a cycle of forecast improvement over time. Seven-day lake forecasts will be published daily on a public website, similar to the "Lake Erie Bloom Position Forecast" tool developed by the National Center for Coastal Ocean Science (NOAA).

c) Project tasks

Task 1: Forecast modeling

The Forecast modeling comprises (1) a one-dimensional model giving a "risk index" of HABs at Clear Lake and (2) a three-dimensional model to predict the exact location of the HABs.

A) Risk Index

- UC Davis will develop a statistical index to predict the onset and extent of periods with low dissolved oxygen levels in the lake as a whole. These episodes have been closely correlated to HABs at Clear Lake.
- To make daily evaluations of the risk index, measured and forecast meteorological data and lake surface and bottom water temperatures are needed. Real-time meteorological data are available from TERC's network at Clear Lake. Real-time lake surface temperature and dissolved oxygen at Clear Lake Oaks (CLO) and Riviera West are available through Big Valley Rancheria WQData website. Hence, we will benefit from the data collected through past investments. The lake bed measurement depth depends on the depth of the intake at the CLO water treatment plant (~3 m). Hence, this project needs to acquire real-time deep temperature and dissolved oxygen (> 10 m) from at least one additional site.

B) Spatial distribution of HABs

- Our three-dimensional lake model for Clear Lake can readily be adapted to provide forecasts of the spatial distribution of the lake conditions. A similar tool has been developed by TERC researchers at Lake Tahoe for lake temperature, surface currents, and wave height (see Lake Tahoe Model Lake Conditions).
- The developed model will utilize (a) a 7-day National Weather Service meteorological forecast to "drive" the model, and (b) remote sensing products for the initial spatial distribution of algae.
- The model will provide a forecasted spatial distribution of the bloom every 3 hours for each of the next 7 days. The result would be similar to the "Lake Erie Bloom Position Forecast" produced by the National Center for Coastal Ocean Science (NCCOS) for Lake Erie (Fig. 2).

Task 2: In-lake data sampling for model calibration and validation. Building local capacity

- We would collaborate with local entities who do HAB sampling and use that data to calibrate and validate model predictions. This includes shoreline monitoring by Big Valley Rancheria, Cal-WATCH, intake water monitoring by water purveyors, and TERC's continuing water quality and algal sampling in all three Arms of the lake. Two funded internships will be created to allow tribal members to participate in that field work and develop new skills.
- We propose the use of real-time autonomous low-cost in-lake systems for the validation of HAB detection. Big Valley Rancheria has two real-time surface sensors to measure chlorophyll-a at CLO and West Riviera. TERC has been developing compact, low-cost ultraviolet-LED optical sensors (with

funding from the Bureau of Reclamation) for *in situ* detection of HABs using UV fluorescence coupled with spectrophotometric detection. This allows for a wide detection of fluorescence within a compact and inexpensive package. We are planning to install a minimum of six sensors across the lake (two on each Arm) and we will use advice from tribal members to select the best locations for their deployment.

Task 3: Display the results of the Early Warning System for HABs. Community benefits

- The daily forecasts and measured lake data will be publicly available through the UC Davis Clear Lake Restoration website. Tribal members, public health agencies, and water purveyors will be a part of a working group established to design the public-facing part of the forecasting tool to ensure that it meets all community needs.
- Predicting HABs will allow water purveyors to be fully prepared for treatment changes. This will save money and improve water quality. As well as providing forecasts of specific areas impacted by HABs, the forecast will indicate areas *not* impacted, thus informing the public of where they can have safe access to huge parts of the lake and shoreline. This helps us move away from the notion that "all of Clear Lake" is impacted by a HAB.
- Once completed, the software product can be very inexpensively maintained in the future.

Project Timeline

Year 1:
- Public Engagement
- Refinement of the one-dimensional model to predict the onset of HABs (risk index)
- Develop three-dimensional model predictions of HAB location
- Develop website
- Installation of low-cost network sensors to provide real-time information for the model

Year 2:
- Continue with tasks started in Year 1
- Validate numerical model results with conventional HABs sampling by Tribes and Water Purveyors, and low-cost real-time sensors
- Fine-tune and adapt models
- Final report

Projected Budget

Task	Year 1	Year 2	Total
Forecasting modeling	$ 100,000	$ 100,000	$ 200,000
In-lake sampling	$ 60,000		$ 60,000
Outreach and Engagement	$ 20,000	$ 20,000	$ 40,000
TOTAL	$ 180,000	$ 120,000	**$ 300,000**

Figures

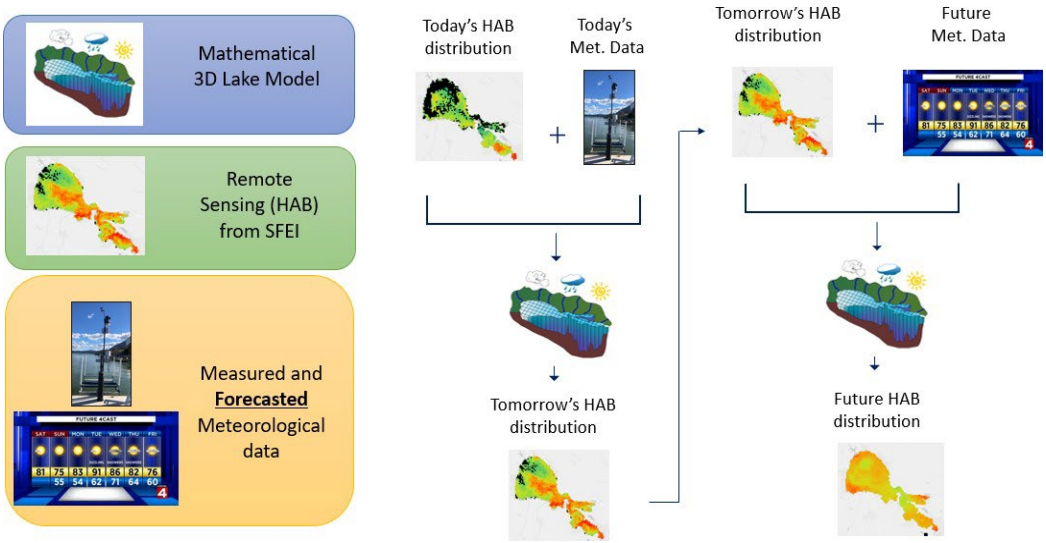

Fig 1. Conceptual diagram of proposed Early Warning System for HABs at Clear Lake

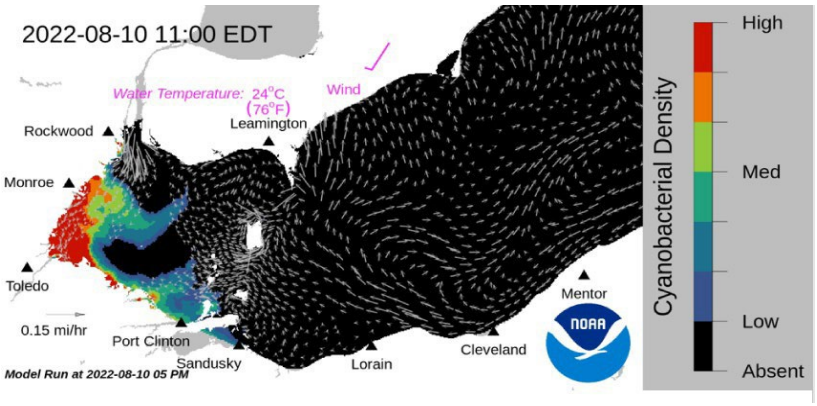

Fig. 2. National Center for Coastal Ocean Science screenshot of the 'Bloom Position Forecast' system at Lake Erie

Contact Information

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  - Dwight Coddington, Public Health Information Officer, dwight.coddington@lakecountyca.gov
- Water Resources Department Lake County (WRD-LC)
  - Angela DePalma-Dow, angela.depalma-dow@lakecountyca.gov
- *Sarah Ryan, Big Valley Rancheria, sryan@big-valley.net*
  - *Unfortunately, we have not received feedback from BVR group on this proposal. Given all the work on HABs conducted by this team, we are hoping to connect and discuss this proposal together very soon.*
- Water Purveyors
  - Lisa Miller – Water quality engineer with Golden State Water Company, lisa.miller@gswater.com
  - Mary Benson – Supervising Water treatment operation in Jago Bay, mary.benson.ca@gmail.com
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Addendum to Address Committee Proposal Requirements for the Proposed Early Warning System to Forecast Harmful Algal Blooms (HABs) in Clear Lake, CA

March 9th, 2023

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

Yes. The system would provide Tribes, water purveyors, agencies, and the public with both a lead time in responding to episodic HABs events and advanced knowledge of which part of the lake is going to be impacted. The development of daily forecasts of HAB location and severity for the next 7 days also depends on the understanding of the causes of HABs in the lake, thereby contributing to the long-term improvement in the health of Clear Lake. As an example of the use of this tool, water purveyors will get up to a week to make orderly preparations for enhanced treatment for drinking water supply, rather than responding to detections once the problem is upon them. This would result in both improvements in the quality of delivered water and a reduction in treatment costs.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

The Early Warning System uses the baseline physical, chemical, and biological conditions (that TERC is currently collecting) to provide forecasts of lake conditions in the coming 7 days. When coupled with an active remediation technology, such as hypolimnetic oxygenation, it enables that technology to be managed to achieve the desired future state (e.g. achieving a minimum DO concentration, a maximum HAB concentration, etc.).

3. How does the project demonstrate progress toward achieving the Committee's vision?

The development of this system will advance the better understanding of the factors causing HABs in the lake and allow the better selection and management of remediation technologies and in the end the improvement of the water quality, health, and beneficial uses of Clear Lake. The project also seeks to be inclusive of all ongoing efforts in this area. For example, data collected by programs developed by Clear Lake Tribes and other stakeholders (e.g. Big Valley Rancheria, CAL-Watch) are all important to improve the robustness of the forecasts.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

Data collected by tribes and others will be used to both calibrate and validate the forecast models; internships will be created to allow tribal members to participate in field work to both use their existing skills and knowledge, and develop a range of new skills; tribal members and other community members will be invited to be part of a working group established to design the public-facing part of the forecasting tool.

5. How will the fully implemented project be maintained in the long term with the local community?

This is a software product that can be very inexpensively maintained in the future. Both the website and the platform where the model will run will be hosted by the UC Davis College of Engineering, where long-term staff can help troubleshoot if issues arise. A different forecasting tool we have developed runs unattended and has required a "manual reboot" twice in the last year.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.

Predicting HABs will allow water purveyors to be fully prepared for treatment changes. This will save money and improve water quality. As well as providing forecasts of specific areas impacted by HABs, the forecast will indicate areas ***not* impacted**, thus informing the public of where they can have safe access to huge parts of the lake and shoreline. This helps the Clear Lake community to move away from the notion that the entire lake is impacted by a HAB. Very often it can just be one part of one Arm. Being able to quantitatively counter media reports that focus on sensationalizing news would provide the tourist industry and other recreational users a means of promoting visitorship and using the lake safely.

7. Describe the outreach/community engagement necessary to build an understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.

We are specifically reaching out to the tribes, water purveyors, and public health agencies to provide the additional data and information we need to incorporate to make the tool both robust and work for the entire community. Tribal members and other community members will be invited to be a part of a working group established to design the public-facing part of the forecasting tool. We will also seek to promote the use of the tool with teachers in the region, as numerous learning opportunities are possible.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.

No permit is required to develop this system.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

Both the investment in Clear Lake models and the monitoring that has occurred over the last 4 years and is continuing are being leveraged to develop this forecasting tool. We are also bringing the experience gained in building a different forecasting tool for Lake Tahoe to this project. We also actively collaborate with researchers at other large lakes (for example, Lake George, NY) that face challenges from HABs.

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

We are using existing and ongoing data sets with the bare minimum of new data.

11. Describe the proposing entity's experience on similar projects.

TERC has built a similar forecasting model for lake conditions (temperature, currents, waves) for Lake Tahoe. The addition of HAB tracking will be made possible through our current modeling activities at Clear Lake. We have developed model applications on lakes across the US, Europe, and South America.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

UC Davis does not have statutory or regulatory responsibilities at Clear Lake.

The second part of this Addendum was initiated in **response to some questions formulated during the last Clear Lake Technical Subcommittee Meeting on January 25th, 2023**. At the request of the BRC Chair, Eric Sklar, TERC has prepared a response to the following questions:

A. How will using meteorological data be used to predict HABs in the early warning system?

Meteorological conditions is the primary driver of lake motions and mixing, and determine the movement of algae (including HABs). As weather forecasting has improved over the last 10 years, it is possible to use 7-day meteorological forecasts to "predict" the lake motions over that same future period, and to do it with a high degree of confidence.

B. If we know the forecasted HABs distribution, are there treatments or actions we can do to minimize HABs?

We can minimize HABs only when we have remediation approaches in place. With Hypolimnetic Oxygenation (HO) in the Oaks Arm, for example, we would expect that HABs would be controlled as the oxygen flow rate would be fine-tuned to provide sufficient oxygen to the bottom of the lake. But, if the lake currents transported a large bloom into the Oaks Arm from say the Upper Arm, an unfortunate chain of events would be initiated. That bloom would quickly die in the Oaks Arm (due to insufficient nutrients), sink to the lake bottom, increase the oxygen demand by decomposing, force dissolved oxygen down, allow phosphorus to be released from the sediments, and then create the conditions favorable to the formation of a new HAB bloom.
With advanced knowledge of the bloom being transported into the Oaks Arm, the operator of the HO would be able to ramp up the oxygen insertion rate to compensate for this.

C. Previous tools such as the San Francisco Estuary Institute (SFEI) have not always lined up with on-the-ground results. How will this tool overcome those issues?

UC Davis has a graduate student (Samantha Sharp) working on improving SFEI remote sensing algorithms to properly represent HAB distribution on the ground, in collaboration with NASA and USGS. Her work is already published here: https://www.frontiersin.org/articles/10.3389/fenvs.2021.612934/full. Her results show that a revised equation to calculate the satellite cyanobacteria index (CI) yields a more robust ground truthing, that is, the match between the field CI and satellite CI is strong (see her Fig. 4A). This improvement increases our faith in our use of the HAB estimates from this remote sensing tool. Our early warning system will employ this updated equation. In addition, the model results will be updated daily with real-time HAB data collected in the field to help confirm the remotely sensed data.

D. How will the impact of fire be incorporated into the warning system?

The model takes into account changes in the light environment and atmospheric deposition of nutrients and smoke particulates due to wildfires. These all impact the rate at which algae grow. Again, with a system such as HO deployed, it will be simple to alter oxygen supply rates to allow for added oxygen demand and nutrient input from wildfires.

E. It will be important to have some thoughts on how this model might be maintained and employed by water managers/regulators.

- System maintenance

This is a software product that can be very inexpensively maintained in the future. Both the website and the platform where the model will run will be hosted by the UC Davis College of Engineering, where long-term staff can help troubleshoot if issues arise. The model runs in the background, automatically ingesting the data it needs from the specified sources, and then outputting the results into a 3-hourly product map. The kinds of issues that arise, once the forecasting tool has been tested, calibrated, and validated are

minor. These include things such as power outages disrupting one of the expected data inputs. Many of these can be set up to automatically reboot. Our past experience has been that these problems are infrequent and quick to fix.

Regarding maintaining this system locally by tribal members, water purveyors, or agencies: While any of these groups are technically adept enough to host the output from the forecasting tool, the tool itself is based on a complex and memory-intensive model. The model has to be run on a massively paralleled computer cluster such as we use at UC Davis or using the services of a company such as Amazon Web Server (AWS). We believe that on balance, the challenges for most groups to fully take over the running of the forecasting tool are far greater than the benefits of simply using the outputs for their individual uses.

- System use by water managers/regulators

The early warning system can be used to provide Tribes, water purveyors, agencies, and the public with a lead time in responding to episodic HAB events, so they can turn on any HAB mitigation systems (such as oxygenation) only when needed to avoid increased costs of treating very impaired waters. In this project, we will invite tribal members, water managers, and agencies to be part of a working group to design the public-facing part of the forecasting tool. NOAA has multiple examples of interactive products for the public and we would like to learn which products are more helpful for the Clear Lake community.

Clear Lake Blue Ribbon Committee

March 8, 2023

USGS Collecting data at high temporal and spatial resolution to support HABs management actions and monitoring in Clear Lake

Project Description

Clear Lake, the oldest and largest natural lake situated entirely in California, has been plagued by HABs since the 1970s. Due to years of decreasing water quality, in 2017 the California legislature created a Blue Ribbon Committee (BRC) to identify and address HABs drivers in Clear Lake. IN 2022, a report by Southern California Coastal Water Research Project (SCCWRP) identified studied drivers of cyanobacterial blooms in Clear Lake[1]. This SCCWRP report collected data in 2020 and 2021 and concluded that periods of anoxia were likely releasing phosphorus from the sediments, which could be providing nutrients to sustain cyanobacterial blooms. One management action, a hypolimnetic oxygenation system (HOS) is scheduled for 2024, providing a unique opportunity to collect data before and after the action and evaluate the impact of the HOS on HABs.

Modeling and monitoring are major priorities for the BRC and tribes surrounding Clear Lake. We will collaborate with the BRC to provide data to improve calibration of their biogeochemical model for Clear Lake, measure the effects of the HOS, and improve remote sensing tools for monitoring HABs.

There are 4 project goals: 1) Collect water quality, nutrient, and phytoplankton data to inform, validate, and improve the UC Davis biogeochemical model in Clear Lake and increase understanding of HABs drivers; 2) Collect biogeochemical data to evaluate impact of HOS system on water quality; 3) Improve the accuracy of novel genus-level remote sensing algorithms for Clear Lake; 4) Improve the effectiveness of lower-cost molecular monitoring methods for tribes around Clear Lake. These goals will improve biogeochemical models to

[1] Florea, K., Stewart, B., Webb, E., Caron, D., and Smith, J. (2022). Environmental Drivers of Cyanobacterial Harmful Algal Blooms and Cyanotoxins in Clear Lake: 2020-2021. Costa Mesa, CA: Southern California Coastal Water Research Project. Technical Report 1261 Available at: https://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/1261_ClearLakeHABs.pdf.

understand HABs drivers, especially the relationship between dissolved oxygen, phosphorus, and cyanobacteria as identified in the SCCWRP report, help evaluate a management action, and technically improve monitoring methods to reduce costs for HABs monitoring.

Task 1: Sonde deployments

Continuous monitoring stations used in the UC Davis Clear Lake biogeochemical model are mostly limited to dissolved oxygen and temperature; only one station collects continuous chlorophyll data. Additional, sondes are maintained by some of the drinking water providers, but these sondes are not off-shore, which limits their data to be used in the biogeochemistry model. Additionally, some sondes are not deployed above the sediment surface, which also limits their use for modeling dissolved oxygen in the Lake. We will add two sondes to existing UC Davis stations in the Oaks Arm of Clear Lake to enable the incorporation of chlorophyll dynamics into the UC Davis biogeochemical model.

Tasks 2 and 3: Boat based mapping and hyperspectral validation

High resolution boat-based water quality mapping will be used to understand spatial variation of nutrients and chlorophyll before (year 1) and after (year 2) of the HOS installation in the Oaks Arm of Clear Lake. We will collect data on approximately 3 days in each year. During mapping, we will also collect boat-based hyperspectral imagery. Legleiter et al. (2022)[2] developed the SMASH algorithm to use imagery to resolve different genera causing HABs. We will use these boat-based hyperspectral data and hyperspectral data from the DESIS camera on the International Space Station to implement and refine the SMASH algorithm to improve detection and tracking of blooms.

Task 4: Molecular and chemical cyanotoxin monitoring methods

Molecular monitoring methods (qPCR) are cheaper than chemical tests (ELISA) for cyanotoxins. Molecular methods, however, only evaluate the potential for toxin production, therefore a correlation needs to be developed with chemical cyanotoxin measurements. Big Valley Band of Pomo Indians has been collecting samples for qPCR analyses in Clear Lake for many years and is still refining qPCR thresholds that would trigger additional toxin sampling. We will collect qPCR and toxin samples during sampling associated with Tasks 2 and 3. This will expand the toxin and qPCR dataset, especially adding more off-shore samples. These additional data will help improve our understanding of the relationship between molecular qPCR and ELISA cyanotoxin analyses. This project will provide additional data to improve the integration of qPCR data with cyanotoxin data into the cyanotoxin monitoring programs led Clear Lake Tribes and Agencies to reduce monitoring costs while still protecting public health.

Project success and deliverables

[2] Legleiter, C. J., King, T. V., Carpenter, K. D., Hall, N. C., Mumford, A. C., Slonecker, T., et al. (2022). Spectral mixture analysis for surveillance of harmful algal blooms (SMASH): A field-, laboratory-, and satellite-based approach to identifying cyanobacteria genera from remotely sensed data. *Remote Sensing of Environment* 279, 113089. doi: 10.1016/j.rse.2022.113089.

1) We will deliver a continuous chlorophyll and phycocyanin dataset from the fixed stations to UC Davis, which will be used to model HABs with the UC Davis biogeochemical model.

2) We will deliver a report on the impact of the HOS on the spatial variability of nutrients and chlorophyll, which will be used to evaluate the effectiveness of HOS in reducing HABs.

3) We will deliver a report that applies the hyperspectral SMASH algorithm and evaluates algorithm performance. This will help refine the SMASH algorithm and advance the use of remote sensing monitoring in Clear Lake.

4) We will deliver a report comparing microcystin concentrations measured by ELISA with microcystin biosynthesis gene abundance measured by qPCR. This will be used by cooperators to establish qPCR thresholds to trigger ELISA monitoring. The qPCR method is cheaper than ELISA and would help the cooperators establish a cost-effective, tiered monitoring approach for cyanotoxins.

Project Timeline:

October 1, 2023 – September 30, 2026

- **Year 1 (2023-2024):** Data collection
- **Year (2024-2025):** Data collection and data analysis
- **Year (2025-2026):** Data analysis and report writing

Projected Budget:

Project Budget: $450,000

- USGS contribution: $350,000
- Clear Lake Blue Ribbon contribution: $100,000

Approximate budget by task:

- Task 1 – Sonde deployments: **$175,000**
- Task 2 – Boat based mapping: **$150,000**
- Task 3 – Hyperspectral validation: **$75,000**
- Task 4 – Cyanotoxin validation: **$50,000**

Contact Information:

- Joe Domagalski, U.S. Geological Survey, California Water Science Center, joed@usgs.gov

Additional Information:

- Letters of support below

UCDAVIS
TAHOE ENVIRONMENTAL RESEARCH CENTER

9/2/2022

UC Davis TERC Letter in Support of USGS HAB Monitoring Proposal

Dear CMF HABs reviewers:

I am wliting to support the CA Water Science Center pre-proposal, *Developing tools to manage and monitor HABsat Clear Lake*. UC Davis is a represenlative on the Governor's appointed Blue R.tobon Committee for the Rehabilitation of Clear Lake. The committee was created in 2017 through California Assembly Bill 707 to implement research and restoration projects *to* improve the Clear Lake ecosystem, which has been severely impacted by HABs sincethe 1970s. Clear Lakeis vital *to* regional economy andis the traditional home of m,tltiple Tribes. HABs contaminate drinking water and impact tribal ceremonies and cultural practices related to Clear Lake.

UC Davis is also a lead institution working on the science to restore Clear Lake, through the establishment of a lake research program and the development of a predictive model. Through these latter efforts UC Davis has already been partnering closely with USGSscientists.

This is anopportune timeforthe CAWSC *to* deepen thepartnership with UCDavis at Clear Lake.In 2024 a hypolimnetic oxygen system (HOS) is slated for installation in the Oaks Arm of Clear Lake, led by UCDavis. The HOS will reduce hypoxia andis intended *to* help reduce the frequency and impact ofHABs on Clear Lake water quality. TheUSGS CMF HABs funds will be used*to* increase the data collected SlUTO\lllding this installation and enhance ourability to assess the efficacy of the HOS. It will also allow increased opportunities for UCDa, s and USGS scientists to collaborate.

To,mderstand how Clear Lakefunctions and*to* evaluate the impacts of the HOS, UC Da, hasdevelopeda biogeochemical model ofClear Lakebut given funding limitations andsizeof Clear Lakewe are limited in the numberofhigh-frequency monitoringslations wecanestablish to collect data for model calibration. Additionally, most ofour stations do not havecltlorophyll sensers, so weare not able *to* model rapid bloom **onsets orrapiddecreases in chlorophyll whenbloomscrash.**

Providingadditional YSI EXO scndes withcltlorophyll sensors will provide valuable data in the Oaks Ann, enhance ourability *to* cahorate ourmodel, and help usevaluate the impact of the HOS. Additionally, the uniquehigh-frequency mappingcapabilities of the CAWSCwillgive usdetailed information about the spatial impact of the HOS has onwater quality.

Lastly, theremote sensingcomponent of the CMFproposal willcontribute new hyperspectral instruments to the UC Davis remote sensing projects on Clear Lake. Our goal is *to* improve the accuracy andavailability of remotely sensed dala *to* better track HAB intensity and provide timely information *to* thepublic about when **and where HABs are occurring.**

Welook forward *to* partnering with the CAWSC in thisproject andlakeadvanlageofthis timely opportunity tohelp evaluate the efficacy of tools, like the HOS, to manage and mitigate the negative impacts of HABs.

Respectfully,

S. Geoffrey Scltladow
Professor of Water Resources andEn, mnental Engineering
Director, Tahoe En, mnental Research Center
University of California, Davis

UC DAVIS (530) 754-8372 (TERC) • One Shields Avenue, Davis, CA 95616
WORLDWIDE WEB: http://terc.ucdavis.edu

Letter of Support for USGS HAB Monitoring Proposal by Jim Steele

USGS Project Review Committee

August 27, 2022

Dear Project Reviewers:

At the last meeting of the Lake County Blue Ribbon technical advisory subcommittee a particularly intriguing proposal was advanced for review by Charlie Alpers. This is a USGS proposal called SMASH to develop remote sensing capacity for identifying cyanobacteria species in the Clear Lake. I completely endorse and support this project.

Clear Lake has been subjected to extreme cyanobacteria blooms for several decades and although many of the causes are known, tracking the blooms and the species causing them has been problematic. Any effective program to manage the lake and watershed to control the problem suffers without this capacity.

Several years ago, I was the consultant hired by the County to explore remote sensing capability of Blue Water Satellite for this purpose and our understanding of the watershed nutrient inputs and the bloom dynamics was greatly enhanced. Following this, the advent of additional watershed and lake studies presently underway by UC Davis and USGS, et al will add to our understanding.

The addition of this proposed remote sensing technique will help fill the lake management package and Clear Lake's protection policy with a feedback management tool. This is very much needed.

Sincerely,

Jim Steele

Jim Steele, Retired.

Konocti-view@hughes.net; 707-295-6198

Formerly: Lake County Supervisor, District 3, retired CA State Ecologist and Branch Chief, CSUC Adjunct Professor freshwater ecology, Consulting Biologist ESA/CEQA/permits, Original member of the BRC.

Letter of Support for USGS HAB Monitoring Proposal- Big Valley Band of Pomo Indians

Bouma-Gregson, Keith

From: Sarah Ryan <sryan@big-valley.net>
Sent: Friday, September 2, 2022 9:22 AM
To: Domagalski, Joseph L; Bouma-Gregson, Keith
Cc: Alpers, Charles N; Kraus, Tamara
Subject: [EXTERNAL] Big Valley letter of support for USGS Clear Lake HABs project

As Environmental Director of the Big Valley Band of Pomo Indians, I am writing in support of the Clear Lake HABs proposal of the USGS. Further developing the ability to use hyperspectral data to determine species identification will help our long-standing cyanobacteria and cyanotoxin monitoring program immensely. Our public health oriented program relies on timely sharing of cyanotoxin data. The USGS proposal would shortcut the identification of the toxigenic species, creating the ability for cyanotoxin monitoring that is using a toxigenic species spatial distribution and temporal focus.

We look forward to collaborations with this work.

Sarah Ryan
Environmental Director/Emergency Management Director
Big Valley Band of Pomo Indians
2726 Mission Rancheria Rd.
Lakeport, CA 95453
www.bvrancheria.com/epa
www.bvrancheria.com/clearlakecyanotoxins

707-263-3924 x132
707-263-5378 fax
707-349-4040 cell

Addendum: Collecting data at high temporal and spatial resolution to support HABs management actions and monitoring in Clear Lake Addendum to Address Committee Proposal Requirements

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

   This collaborative project with UC Davis researchers will generate data to improve the UC Davis biogeochemical model for understanding drivers of cyanobacterial blooms in Clear Lake. The project will also generate data to evaluate the impact of a hypolimnetic oxygenation system in Oaks Arm.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

   In the proposal we describe the current prevalence of cyanobacterial blooms over the last several decades in Clear Lake. The desired future state will have fewer and less intense cyanobacterial blooms.

3. How does the project demonstrate progress towards achieving the Committee's vision?

   The project will provide new data and understanding on the drivers of cyanobacterial blooms which can be used to support future management decisions on Clear Lake re-mediation.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

   The proposal was shared with Sarah Ryan (Big Valley Band of Pomo Indians) during the development stage, and she provided a letter of support for the proposal. We also included in the proposal a comparison of cyanotoxin concentrations and qPCR gene copy concentrations to expand the dataset comparing cyanotoxin concentrations and qPCR gene copies in Clear Lake. With more data to refine the relationship

5. How will the fully implemented project be maintained in the long-term with the local community?

   This project is designed to support projects that are already maintained by the local community. UC Davis has a biogeochemical model and will continue to be working on Clear Lake. The cyanotoxin and qPCR data will support ongoing monitoring by the Big Valley Band of Pomo Indians. This project will generate short-term data to support long-term projects and not all aspects of the proposal need to be maintained after the project finishes.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.
   The proposal will generate data to understand drivers about cyanobacterial blooms in Clear Lake and reducing the frequency and intensity of cyanobacterial blooms at Clear Lake will improve tourism to the county.

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.
   The U.S. Geological Survey researchers will provide project updates at appropriate times to the Clear Lake technical advisory committee, will participate in community wide demonstrations of the project, and provide updates to the Native American tribes of Lake County.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.
   Not applicable for this proposal

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

   This proposal was designed with input from UC Davis researchers and will support their biogeochemical model. It also provides open-water cyanotoxin and qPCR data to supplement the monitoring done by Big Valley Band of Pomo Indians and provide more information for evaluating the relationship between qPCR data and cyanotoxin concentrations.

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

    This project will fill existing data gaps. There are limited sondes deployed in the Oaks Arm that include chlorophyll sensors. Many of the sondes that are deployed are along the shoreline or are not at the appropriate depth, which limits the ability of the data to be incorporated into the UC Davis biogeochemical model. We will also be collecting high-resolution spatial data on water quality parameters to provide baseline data in Oaks Arm before installation of a hypolimnetic oxygenation system.

11. Describe the proposing entity's experience on similar projects.

    The USGS Biogeochemistry (BGC) group has installed and maintained over a dozen water quality stations in the Sacramento-San Joaquin River Delta for over ten years. The group has extensive experience collecting water quality data. The BGC group has also been collecting high-resolution mapping data for over 5 years, which has resulted in multiple publications[i].

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

    Not applicable for this proposal

[i] Stumpner, E. B., Bergamaschi, B. A., Kraus, T. E. C., Parker, A. E., Wilkerson, F. P., Downing, B. D., et al. (2020). Spatial variability of phytoplankton in a shallow tidal freshwater system reveals complex controls on abundance and community structure. *Science of The Total Environment* 700, 134392. doi: 10.1016/j.scitotenv.2019.134392.

Fichot, C. G., Downing, B. D., Bergamaschi, B. A., Windham-Myers, L., Marvin-DiPasquale, M., Thompson, D. R., et al. (2016). High-Resolution Remote Sensing of Water Quality in the San Francisco Bay–Delta Estuary. *Environ. Sci. Technol.* 50, 573–583. doi: 10.1021/acs.est.5b03518.

Bergamaschi, B. A., Kraus, T. E. C., and Downing, B. (2020). Assessing spatial variability of nutrients and related water quality constituents in the California Sacramento-San Joaquin Delta at the landscape scale: High resolution mapping surveys. *U.S. Geological Survey data release*. doi: https://doi.org/10.5066/P9FQEUAL.

May 5, 2023
To: Chair and members of the Blue Ribbon Committee for the Rehabilitation of Clear Lake

SSCRA Cobb Mountain Watershed Education and Restoration Program REVISED

Attached please find our revised project proposal building on our current work, funded by BRC and a PG&E "Nature Positive Innovations" grant, that builds community cultural connections to active rehabilitation of creeks in the Clear Lake watershed. Previously, SSCRA has presented the BRC with a vision expanding our work - looking to expand the model to other communities in the Clear Lake basin. ***We are now proposing to continue and intensify our work within the Cobb Mt. area***.

Over the past several months, as our project team has been working with local creekside land owners, under the guidance of Tribal members, we have become more excited about how this work has been growing a partnership both within our team and with the community. We feel that resources would be much better allocated to continuing to establish a firm local culture of riparian stewardship in relationship with local Tribal partners. In this we have been inspired by the response of the community, including private, commercial and institutional landowners.

Another significant change in our proposal is that, while SSCRA will continue as the administrator of the project, the proposal to the BRC is being submitted by our team as a whole, highlighting the special synergies we have discovered over the past several months of working together.

The Cobb WERP Project Team:

- Eliot Hurwitz, Director, SSCRA
- Magdalena Valderrama, Director, SSCRA
- Chris Nettles, PhD., Cobb Area Council, Community Psychologist
- Jeanine Pfeiffer, PhD., Ethno-ecologist
- Ron Montez, Tribal Historic Preservation Officer, Big Valley Band of Pomo Indians
- Sarah Ryan, Director of Environmental Protection, Big Valley Band of Pomo Indians
- Corine Pearce, Master Pomo Basketweaver, and Eco-cultural Educator
- Anthony Falzone, Principal, Flow West Geotechnical Engineers,
- Lindsay Dailey, Director, Tribal Ecosystem Restoration Alliance

Clear Lake Blue Ribbon Committee

DRAFT *5/5/2023*

Cobb Watershed Education and Restoration Program

Mobilizing community capacity in partnership with local Tribes for long-term restoration and stewardship of Clear Lake tributaries.

The **Cobb Watershed Education and Restoration Program** (**Cobb WERP**) has two primary objectives:

(a) **Improve Clear Lake watershed conditions by rehabilitating Clear Lake tributaries** with a focus on stream flows and water quality, riparian habitat, and culturally significant species.

(b) **Build a culture of long-term partnership between local Tribes and private landowners** to co-evaluate, co-research, co-design, co-plan, co-rehabilitate and co-steward riparian properties along Clear Lake tributaries.

The **Cobb WERP** builds on current programming in the Cobb Mountain area involving collaborative educational and restoration activities with landowners along Adobe, Kelsey, and Cole creeks and their tributaries. Our work recognizes that the health and water flows of upstream creeks in the Cobb Area Watershed are intrinsically connected with downstream tributary health and flows, all the way to Clear Lake. By engaging creekside property owners – including multi-generation families, small businesses, and the local water district – we address the impacts of riparian management on the Lake watershed, the tributaries feeding into the Lake, and the Lake itself.

The **Cobb WERP** builds on the successful recruitment and training of creekside property owners in the Cobb Watershed, and initial collaborative restoration and stewardship activities undertaken with Tribal partners in four locations. Multiple workshops involving over sixty people have included instruction in cultural landscapes by Tribal leaders alongside water monitoring, invasive species removal, sedge bed plantings, forest thinning, and the tending of willow and other culturally significant riparian species. Our work has been funded with $30K in seed money through the BRC to operate the program through July 2023, augmented by $100K from a PG&E Nature Positive Innovations grant to extend operations through December 2023. This proposal requests funding to deepen and expand our work through 2025.

The **Cobb WERP** is based on the understanding that ecosystem health, in this case the basic ecological integrity of Clear Lake, is inextricably bound up with the lives of the people who live in the watershed. In fact, this relationship has always been the case, stretching back the thousands of years that human beings have made the Clear Lake basin home. The Committee has acknowledged the need to integrate the complex socioeconomic factors that affect the Lake into its rehabilitation paradigm. This includes the need to promote active participation in Lake watershed rehabilitation programs by community members, including aligning rehabilitation projects with other, important community priorities and goals spanning economic, social, and cultural areas.

The **Cobb WERP** is a "long game" program, with specific short-term, on-the-ground deliverable rehabilitation actions, including keystone sites where our collaborative education and field demonstration activities serve as catalysts for recruiting and training additional creekside property owners. Our on-site partnerships enable us to address climate-change induced conditions, including reducing wildfire risk, mitigating drought and heightened water temperatures, and protecting culturally significant species. By enhancing water flows and water quality along Adobe, Kelsey, and Cole creeks, sharing local resilience practices, and working in close partnerships with local Tribes, we also help restore critical spawning habitat for the endangered and endemic chi [Clear Lake Hitch].

Acknowledging the direct links between poor upstream water quality and depressed creek water flows leading to Clear Lake, the **WERP** targets watershed management practices in the Cobb Mountain community by recruiting local property owners to participate in "hands-on" workshops weaving together resource management training with direct actions to match specific site conditions and landowner concerns.

In consultation with local tribal authorities, the **WERP** also acknowledges a history of limited access to traditional gathering areas that has undermined food sovereignty and cultural practices. Every workshop we hold, and every direct action we take during this project [and beyond] involves tribal knowledge holders and teachers, who combine their expertise with that of other topical specialists.

The **WERP** approach draws upon the regional success of programs including STRAW: **S**tudents and **T**eachers **R**estoring **A W**atershed in Sonoma County (where the successive recruitment of landowners with waterside properties eventually restored 30 miles of riparian habitat), Big Valley Rancheria's EPA water quality monitoring program, Lake County's Tribal EcoRestoration Alliance (TERA)'s multicultural collaborative focusing on restoration and indigenous stewardship, and Anderson Valley's "Think Like a Watershed" resilient lands symposium (an event that brought together farmers, ranchers, landowners, conservationists, and hydrological, landscape, and ecological specialists).

Recognizing the diversity of riparian microhabitats along Adobe, Kelsey, and Cole Creeks, we have assembled a "Dream Team" of regional specialists in geomorphology, restoration ecology, biocultural diversity, conservation, and participatory engagement (see Table 1 below) – who flexibly and responsively interact with local landowners when assessing and designing

innovative restoration and stewardship actions (rather than dictating a specific sequence of recommendations).

Areas covered by the Clear Lake Community Watershed Restoration Program

Water & Earth Sciences	Resource Management	Cultural Sciences	Community process
Climate change Hydrologic cycles Groundwater inputs and withdrawals Riparian restoration, design and analysis Stormwater detention and retention Sediment management Water rights Fish passage Biological invasions Habitat enhancement	Clean Water Act Water quality monitoring Lake & Streambed Alterations (LSAs) Harmful Algal Blooms (HABs) & cyanotoxins Native and endangered species Fire risk reduction Resilience and adaptation Beaver dam analogs (BDA) Bank enhancement Channel bed stabilization	Cultural landscapes Biocultural diversity Culturally significant species Indigenous science Traditional ecological knowledge (TEK) TEK integration with engineering Cultural burning Tribal Beneficial Uses within waterbodies Water rights	Participatory engagement Citizen science Evaluation and monitoring Justice, Equity, Diversity & Inclusion (JEDI) Cultural sensitivity Active listening Team coordination Mediation and facilitation Public outreach

TABLE 1

Project lead

The Seigler Springs Community Redevelopment Association (SSCRA) plays a leading role in addressing climate change impacts and developing resilience in the Cobb Mountain community. In 2020-22 SSCRA assembled the resources to create the strategic document, “Regeneration After Catastrophic Wildfire: A Community Resilience & Development Strategy,” after being commissioned by the Cobb Area Council to do so. This community-based strategy has provided a basic platform from which the current restoration program is operating. The Cobb WERP will continue to strengthen this core community support for restoration.

SSCRA will manage contracted specialists for topics listed under “Community Process” in Table 1. SSCRA will serve as project facilitators and administrators, in collaboration with the following partners:

Contractual partners

• FlowWest: provides GIS mapping expertise and deliverables; participates in planning and curriculum design and will provide instruction on nature-based water management, geomorphology and associated topics listed under “Water & Earth Sciences” and “Resource Management” in Table 1.

• Tribal Eco-Restoration Alliance: provides expertise in nature-based resource management and stewardship (e.g., cultural burning, bank stabilization, beaver analogs, etc.), invasive species management, cultural landscapes and traditional ecological knowledge, and cultural sensitivity. TERA will participate in project planning, curriculum design, instruction, fieldwork, and direct

actions on associated topics listed under “Water & Earth Sciences,” “Resource Management,” “Cultural Sciences,” and “Community Process” in Table 1.

Community partners

• Forest Stewardship Committee of the Cobb Area Council: provides broader local community connections, outreach, and legitimacy; recruits Cobb Area Watershed property owners, and develops and maintains deep relationship connections with large parcel owners.

• Cobb Area Council: as the designated municipal advisory council, amplifies the community’s voice to the County Board of Supervisors regarding policies and practices in the Cobb Area Watershed.

• The Cobb Mountain Water District: as operator of all the water systems in the community, the District has purchased ownership of all (14) of the major sources of drinking water in the area, including surrounding environments. As committed stewards of the watershed the Water District is a key partner in the overall health of the watershed.

• Mandala Springs Retreat Center: provides the sites for ongoing field studies and larger public gatherings.

• Big Valley Band of Pomo Indians: the tribe’s EPA Department provides expertise in water and cyanotoxin monitoring, tribal beneficial uses of aquatic ecosystems, and the conservation of endemic and culturally significant aquatic species during project planning, curriculum design, and instruction and fieldwork exercises on associated topics listed under “Water & Earth Sciences,” “Resource Management,” and “Cultural Sciences” in Table 1.

• Additional Tribal partners: Scotts Valley Band, Robinson Rancheria, Habematolel (in discussion)

Project goals:

1. Engage the Cobb Mountain community in building stronger, multicultural, and cross-sectoral relationships that enable a widening project participant base of landowners along the Adobe, Kelsey, and Cole Creek systems.

2. Build a strong coalition of local property owners in the Cobb Area Watershed willing to collaboratively undertake immediate, medium-term, and long-term nature-based restoration and stewardship actions on their creekside lands that support enhanced upstream riparian habitat and associated native, endangered, and culturally significant species.

3. Support a multicultural, multisectoral community coalition of expert practitioners – including scientists, engineers, Tribal staff and Tribal Culture Bearers – who provide instruction and oversight of field activities in applied water and earth sciences, cultural and ecological resource management, cultural sciences, and community processes. see Table 1).

4. Develop climate resilient solutions to enhance upstream riparian conditions in the Cobb Area Watershed that directly contribute to positive downstream habitat conditions for native, endangered and culturally significant species – all the way to Clear Lake.

Project outcomes:

a. Up to sixteen additional Cobb Mountain community property owners (individual and institutional) managing at least 1000 acres of watershed property along Adobe, Kelsey, and Cole creeks where innovative, nature-based restoration and stewardship actions are initiated.

b. Improved riparian habitat evidenced by: reduced erosion and sediment loads, enhanced water quality conditions and water flows, and improved vegetation health and species composition, including increased populations of native, endangered, and culturally significant species.

c. A newly expanded partnership network of expert practitioners from local tribes and regional agencies who provide training, guidance, and oversight.

d. A graduated, iterative training-accompanied-by-direct-action intervention model that is continuously refined and expanded throughout the Cobb Area Watershed and beyond.

e. A project manual, digital resource binder, and YouTube channel for supporting and recruiting additional area property owners in successive years.

Tribal Guidance

A central orientation and commitment of the Program is to build core functional partnerships between current landowners, community groups, and local tribes. The Program recognizes and calls out the active participation and guidance from Lake County's tribal nations as a critical, scientific requirement for the rehabilitation of the Lake based on millennia worth of careful observation and methods existing among them now, and in addition to the current ability of watershed science and research to provide supporting data, analysis, and modern analogs for functions once held by species that have been decimated in the past 150 years (e.g. beavers).

Community Buy-in

The Program is also based on a rigorous social science model of community capacity building (see addendum 9 below), and follows recent demonstrated successes in the Cobb Mt. community

An essential dimension of the **WERP** will be to further evolve the Cobb Mt. model of self-organizing, planning and long term sustainability, building on the team assembled for the current Cobb Watershed program and in partnership with the Cobb Area Council, especially its Forest Stewardship Committee. Additional local organizing and education and buy in cultivated throughout the Cobb Mt. community.

This activity will share with the community members the evolving story initiated through the current WERP and progressively draw more and more community members into participation .

Contemporary social science recognizes that communities operate as "complex adaptive systems." Thus, building effective long-term positive community participation in the rehabilitation of Clear Lake will require the kind of community capacity building outlined in this program. We anticipate that the **Cobb WERP** will provide communities throughout the watershed with a model of how to define a range of specific projects and activities that will

synchronize economic and human development with the best environmental management practices – while building comprehensive community solidarity and prosperity.

This approach has three significant aspects: 1) Balancing the self-interest of various constituencies (Landowners, tribes, etc.) with the needs of the broader social-ecological system by empowering people to develop a collective vision; 2) Emphasizing ongoing **relationships** rather that single transactions (people who anticipate ongoing relationships are likely to engage in pro-mutuality); 3) Optimizing the "whole complex community system" by weaving individuals within the community into a strongly connected local network within a context of cultural practices, local environmental conditions, histories, and narratives. This approach has strong support in the social science literature.

Project Timeline:

Pre-BRC Award - Visioning and community outreach continues

NOTE: that each workshop will invite and welcome participation in the on-site restoration activities from members of previous cohorts as well as from the community at large.

Year One -
Month 1-2 Enrol program cohort #2 - 7 project sites, with up to 15 program participants
Month 2 -Site evaluation visits and Curriculum development for sites 1-4,
Month 3 - Workshop #1
Month 4 - Workshop # 2
Month 5 - Mid year Planning and scheduling buffer
Month 6 - Workshop # 3
Month 7 - Workshop #4
Month 8 - Site evaluation visits and Curriculum development for sites 5-7
Month 9 - Workshop #5
Month 10 - Workshop #6
Month 11 - Workshop #7
Month 12 - Cohort Evaluation and summary gathering (including cohort #1)

Year Two
Month 1-2 Enrol program cohort #3 - 7 project sites, with up to 15 program participants
Month 2 -Site evaluation visits and Curriculum development for sites 8-11,
Month 3 - Workshop #8
Month 4 - Workshop # 9
Month 5 - Mid year Planning and scheduling buffer
Month 6 - Workshop # 10
Month 7 - Workshop # 11
Month 8 - Site evaluation visits and Curriculum development for sites 12-14
Month 9 - Workshop #12
Month 10 - Workshop #13
Month 11 - Workshop #14
Month 12 - Cohort Evaluation and summary gathering (including cohort #1 and #2)**]**

Cobb Watershed Education and Restoration Program

Scope of Work

Task No. **Task Description**

1 **Community diffusion of innovation** Building land stewardship partnerships with Tribal members is a classic case of cultural innovation, especially in the context of how the community socioeconomic character adapts and embraces this practice . There is significant research on this process of "innovation diffusion" that informs this project

1.1 **Up to 4 x 2-hour local events** on project themes and objectives - These will be stand-alone events, weekday evenings or weekends, co-sponsored by other community organizations, that will cast the widest net within the community and artciulate the project's objectives, themes and opportunities. It will feature local program participants sharing the value of the work being done both for their own properties as well as the links and relationships being grown.

1.2 **Cultivation, empowerment and coaching of 5 local opinion leaders**: Key to innovation diffusion is the active promotion of project objectives and themes by respected individuals with extensive networks within the community. Some of these people will be program participants and alumni, others may be sympathetic supporters. The WERP project will provide these community leaders with the materials (e.g. FAQ lists) and work with each one to solidify their understanding of the program and help them identify means to share this understanding with their networks.

1.3 **locally focused media outreach**: 2 news stories, 2 edited video presentations (YouTube etc.). Extensive video and still footage of the program is being collected that powerully illustrates the benefits of the ptoram This will be editied and made available via all outlets including social media. News stories will be placed in local and regional newspapers.

1.4 **6 x 15-30 minute presentations to local community groups** - Project team members will atttend meetings of local commuity groups, including the Cobb Area Council, The Friends of Boggs Mountain, The Cobb Mt. Lions Club, the various Cobb area Firewise community groups, the local business community organization that include the Cobb area, including the Middletown Area Merchants Association and the Kelseyville Business Association

2 **Curriculum Development, Planning, Project Management and Evaluation** This project embraces an intesely collaborative design, with a nine-member core team of highly experienced professionals, with essential guidance from senior Tribal members. This is key to the power and the promise of the program. All team members are involved in keeping the various elements of the project synchronized. Curriculum development involves mining and curating the deep resources available to each team member and packaging it for use by local property owners. The final outcome of this work will be a treasure of useful guidance for the entire Clear Lake watershed

2.1 **Project administration**: grantor relations, reporting, contractor management, online project workspace management: Regular presentations and report to the BRC

2.2 **Up to 20 remote team planning & curriculum design and development meetings**. Over the past nine months that the project team has been working together, we have built an intensely collaborative working process, guided by Tribal members. In team meetings we are working to combine contemporary riparian science, Traditional Ecological Knowledge, eco-cultural understanding, an understanding of the existing regulatory and legal context, the social science of innovation diffusion, and strategic community planning and economics.

2.3 **Arranging/managing 10 site visits and 7 weekend workshops, developing and compiling course materials and documentation, venue logistics.** Coordination of team members This results in an extensive binder of materials pertinent to the site including practical, illustrated instructions and references from the professional literature. Arranging for printing and binding of materials.

2.4 **Project evaluation** Formal evaluations of both the practical and cultural effects of the program, including periodic post-treatment monitoring for water quality and ongoing surveys of program participants.

2.5 **Audio-video** - All workshops are being recorded with multiple cameras both in classroom and onsite

2.6 **Project team communication and coordination** - in addition to approximately bi-monthly team meetings, team members are in regular communication as the program evolves and as we learn more about the unique quality of both the local micro ecologies and the social landscape of the community.

2.7 **Curriculum Development, Instructor recruitment**- this task is the actual compiling of materials for each workshop, including original materials as well as designing the learning objectives and materials needed and recruiting the best instructors for each workshop.

2.8 **On-site consultations with landowners** for restoration innovations (including prep for mini plans), Consultations with a riparian restoration specialist. In addition to the specific work to e done at each site during the workshop, each site will be evaluated for long term rehabilitation

2.9 **mini stewardship plans**; On the basis of the previous task, as well as experience from the site workshop basic long term stewardship plans will be developed for each site, including maps, treatment plans, plant lists, etc.

3 Site Visits, Workshops/Restorations, Lectures

3.1 **10 site evaluation visits (3 full days @ 3-4 sites/day)** An intial site visit to each workshop site , by all team members, develops an evaluation of the challenges of the site in colaboration with the property owners. This initial site visit guides the development of the curriculum material for a workshop centered on that site (task 3.2).

3.2 **7 weekend workshops (1-2 per quarter) including on-site restoration actions** This is the core activity of the programand and involves bringing all of the elements of the project together to address a specific creekside property. Each workshop includes at least a four hour morning "classroom" session, at which team members, as well as additional invited experts, provide understanding of the principles behind the reahbilitation work to be done on the site in the afternoon. A second morning session is also optional, for additional presentations and additional site work.

3.2.1 **Onsite labor for restoration & stewardship** For each workshop, restoration crews will supplement workshop participants

3.3 **On-site consultations with landowners** on water quality & permitting - in particular each participating property owners will be instructed in ongoing water quality monitorning procedures

3.4 Instruction on water quality monitoring, pesticides, hazardous algal blooms, county and state permitting policies

3.5 Instruction on cultural sensitivity, traditional ecological knowledge, cultural landscapes, culturally significant species

3.6 Onsite water sampling and creek assessment

3.7 Water sample data entry into Water Quality Exchange (WQX) database

3.8 re-assessment of 6 previous sites with simple report on effects of restoration and further recommendations

3.9 Cobb area watershed geophysical review

3.10 Field lecture during training workshop

3.11 **Travel time for geotechnical advisor** forfield site visits

Cobb Watershed Education and Restoration Program

BUDGET

Task No.	Task Description		COST		BRC Request		MATCH
1	**Community diffusion of innovation**				70%		30%
1.1	up to 4 x 2-hour local events on project themes and objectives	($	5,250)				
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	($	8,200)				
1.3	locally focused media outreach: 2 news stories, 2 edited video presentat	($	4,850)				
1.4	6 x 15-30 minute presentations to local community groups	($	2,690)				
	SUB TOTAL	**($**	**20,990)**	**($**	**14,693)**	**($**	**6,297)**
2	**Curriculum Development, Planning, Project Management and Evaluation**						
2.1	Project administration: grantor relations, reporting, contractor management, online project workspace management	($	5,000)				
2.2	Up to 20 x 2-hour remote team planning & curriculum design and development meetings	($	26,738)				
2.3	Arranging/managing 10 site visits and 7 weekend workshops, developing and compiling course materials and documentation, venue logistics	($	10,000)				
2.4	Project evaluation	($	11,200)				
2.5	Audio-video specialist(s)	($	4,000)				
2.6	Project team communication and coordination	($	23,500)				
2.7	Curriculum Development, Instructor recruitment	($	9,000)				
2.8	On-site consultations with landowners for restoration innovations (including prep for mini plans), Consultations with a riparian restoration specialist & curriculum development	($	7,821)				
2.9	mini stewardship plans; map, treatment plans, plant lists	($	4,320)				
	SUB TOTAL	**($**	**101,579)**	**($**	**71,105)**	**($**	**30,474)**
3	**Site Visits, Workshops/Restorations, Lectures**						
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	($	13,680)				
3.2	7 weekend workshops (2 per quarter) including on-site restoration actio	($	36,480)				
3.2.1	Onsite labor for restoration & stewardship innovations	($	26,640)				
3.3	On-site consultations with landowners on water quality & permitting	($	3,750)				
3.4	Instruction on water quality monitoring, pesticides, hazardous algal blooms, county and state permitting policies	($	1,350)				
3.5	Instruction on cultural sensitivity, traditional ecological knowledge, cultural landscapes, culturally significant species	($	1,125)				
3.6	Onsite water sampling and creek assessment	($	2,813)				
3.7	Water sample data entry into Water Quality Exchange (WQX) database	($	5,625)				
3.8	re-assessment of 6 previous sites with simple report on effects of restoration and further recommendations	($	6,000)				
3.9	Cobb area watershed geophysical review	($	3,501)				
3.10	Field lecture during training workshop	($	2,625)				
3.11	Travel time to field site x 6 visits	($	5,907)				
	SUB TOTAL	**($**	**109,496)**	**($**	**76,647)**	**($**	**32,849)**
	TOTAL LABOR	**($**	**232,065)**	**($**	**162,445)**	**($**	**69,619)**

DIRECT COSTS

Task No.	Description		
	Travel per GSA mileage rate	($	3,850.00)
	Food for program participants, space rental,	($	4,000.00)
	Printing: course manuals, large-scale maps	($	4,000.00)
	Project supplies	($	1,200.00)
	Open Access Publication fees	($	6,000.00)
	Conference/Symposium presentation fees	($	1,000.00)
	Laboratory/testing sampling and shipping supplies	($	2,000.00)
	Shipping costs for water samples	($	950.00)

Water, plant, and fish tissue testing at outside labs	($	8,000.00)				
re-assess previous year sites - water sampling etc.	($	2,000.00)				
TOTAL DIRECT COSTS	**($**	**33,000.00)**	**($**	**23,100)**	**($**	**9,900)**
TOTAL INDIRECT		**$15,829**	**($**	**11,080)**	**($**	**4,749)**
TOTAL PER YEAR	**($**	**280,894)**	**($**	**196,625)**	**($**	**84,268)**
TOTAL 2 YEAR PROGRAM	**($**	**561,787)**	**($**	**393,251)**	**($**	**168,536)**

Seigler Springs Community Redevelopment Association - 2 Principals: Community Weaving and Adminstration

Task No.	Task Description - PER year	Hours	Rate	Cost
1	**Community diffusion of innovation**		$50	
1.1	up to 4 x 2-hour local events on project themes and objectives	60)		$3,000
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	60)		$3,000
1.3	locally focused media production: 2 news stories, 2 edited video presentations (YouTube etc.)	40)		$2,000
1.4	6 x 15-30 minute presentations to local community groups	24)		$1,200
1.5	Journal articles and conference presentations			
	SUBTOTAL	**184)**		**$9,200**
2	**Curriculum Development, Planning, Project Management and Evaluation**			
2.1	Project administration: grantor relations, reporting, contractor management, online project workspace management	100		$5,000
2.2	Up to 20 remote team planning & curriculum design and development meetings (2 hrs each x 2 staff)	80		$4,000
2.3	Arranging/managing 10 site visits and 8 weekend workshops, developing and compiling course materials and documentation, venue logistics	200		$10,000
2.4	Project evaluation	30		$1,500
2.5	Audio-video specialist(s)	80		$4,000
2.6	project team communication and coordination @ 5 hrs/month	50		$2,500
2.7	Curriculum Development, Instructor recruitment			
	SUBTOTAL	**540)**		**$27,000**
3	**Site Visits, Workshops/Restorations, Lectures**			
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	48		**$2,400**
3.2	8 weekend workshops (2 per quarter) including on-site restoration actions	128		**$6,400**
	SUBTOTAL	**176)**		**$8,800**
	TOTAL LABOR HOURS AND COSTS	**900**		**$45,000**

DIRECT COSTS

Task No.	Description	qty		Total Cost
3.2	Food for program participants, space rental,	**8**	**$500**	**$4,000**
1.1, 3.2	Printing: course manuals, large-scale maps	**8**	$500	**$4,000**
3.2	Project supplies	**8**	$150	**$1,200**
1.5	Open Access Publication fees	**2**	$3,000	**$6,000**
1.5	Conference/Symposium presentation fees	**2**	$500	**$1,000**
ALL	Travel per GSA mileage rate	300	$0.625	**$188**
	TOTAL DIRECT COSTS			**$16,388**
	TOTAL LABOR AND DIRECT COSTS			**$61,388**
	INDIRECT COSTS 15%			**$9,208**
	TOTAL			**$70,596**

Chris Nettles PhD., Community Psychologist

Task No.	Task Description - PER year	Hours	Rate	Cost
1	**Community diffusion of innovation**		$50	
1.1	up to 4 x 2-hour local events on project themes and objectives	**45)**		**($ 2,250)**
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**30)**		**($ 1,500)**
1.3	locally focused media production: 2 news stories, 2 edited video presentations (YouTube etc.)	**20)**		**($ 1,000)**
1.4	6 x 15-30 minute presentations to local community groups	**15)**		**($ 750)**
	SUBTOTAL	**110**		**($ 5,500)**
2	**Curriculum Development, Planning, Project Management and Evaluation**			
2.2	Up to 20 remote team planning & curriculum design and development meetings (2 hrs each)	80		**($ 4,000)**
2.6	project team communication and coordination @ 5 hrs/month	50		**($ 2,500)**
2.4	Project evaluation	80		**($ 4,000)**
	SUBTOTAL	**210**		**($ 10,500)**
3	**Site Visits, Workshops/Restorations, Lectures**			
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	24		**($ 1,200)**
3.2	8 weekend workshops (1-2 per quarter) including on-site restoration actions	64		**($ 3,200)**
	SUBTOTAL	**88)**		**($ 4,400)**

	TOTAL LABOR HOURS AND COSTS	**408**			**$20,400**
	Travel per GSA mileage rate	150	0.625	**($**	**94)**
	TOTAL			**($**	**20,494)**

JEANINE PFEIFFER PhD., Ethnoecologist

Task No.	Task Description - PER year	Hours	Rate		Cost
1	**Community diffusion of innovation**		$50		
1.1	up to 4 x 2-hour local events on project themes and objectives				
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**10)**		**($**	**500)**
1.3	locally focused media production: 2 news stories, edited video presentation (YouTube etc.)	**5)**		**($**	**250)**
1.4	1 x 20-30 minute presentations to local community groups	**2)**		**($**	**100)**
	SUBTOTAL	**17)**		**($**	**850)**
2	**Curriculum Development, Planning, Project Management and Evaluation**				
2.2	Up to 20 remote planning & curriculum design and development meetings (2 hrs each)	40		**($**	**2,000)**
2.4	Project evaluation	50		**($**	**2,500)**
2.6	project team communication and coordination @ 5 hrs/month	50		**($**	**2,500)**
2.7	Curriculum Development, Instructor recruitment	180		**($**	**9,000)**
	SUBTOTAL	**320)**		**($**	**16,000)**
3	**Site Visits, Workshops/Restorations, Lectures**				
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	24		**($**	**1,200)**
3.2	8 weekend workshops (1-2 per quarter) including on-site restoration actions	64		**($**	**3,200)**
	SUBTOTAL	**88)**		**($**	**4,400)**
	TOTAL LABOR HOURS AND COSTS	**425**		**($**	**21,250)**
	Travel per GSA mileage rate	650	0.625	**($**	**406)**
	TOTAL			**($**	**21,656)**

CORINE PEARCE, Master Pomo Basketweaver and EcoCultural Educator

Task No.	Task Description - PER year	Hours	Rate		Cost
1	**Community diffusion of innovation**		$90		
1.1	up to 4 x 2-hour local events on project themes and objectives				
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**10)**		**($**	**900)**
1.3	locally focused media production: 2 news stories, edited video presentation (YouTube etc.)	**5)**		**($**	**450)**
1.4	6 x 20-30 minute presentations to local community groups	**2)**		**($**	**180)**
	SUBTOTAL	**17)**		**($**	**1,530)**
2	**Curriculum Development, Planning, and Evaluation**				
2.2	Up to 20 remote planning & curriculum design and development meetings (2 hrs each)	40		($	3,600)
2.6	project team communication and coordination @ 5 hrs/month	50		($	4,500)
2.4	Project evaluation	10		($	900)
	SUBTOTAL	**100)**		**($**	**9,000)**
3	**Site Visits, Workshops/Restorations, Lectures**				
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	24		($	2,160)
3.2	8 weekend workshops (1-2 per quarter) including on-site restoration actions	64		($	5,760)
	SUBTOTAL	**88)**		**($**	**7,920)**
	TOTAL LABOR HOURS AND COSTS	**205**			**18,450**
	Travel per GSA mileage rate	1200	0.625	**($**	**750)**
	TOTAL				**19,200**

RON MONTEZ - Big Valley Band of Pomo Indians Tribal Historic Presevation Officer

Task No.	Task Description - PER year	Hours	Rate		Cost
1	**Community "diffusion of innovation"**		**$90**		
1.1	up to 4 x 2-hour local events on project themes and objectives				
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**10)**		**($**	**900)**
1.3	locally focused media production: 2 news stories, edited video presentation (YouTube etc.)	**5)**		**($**	**450)**
1.4	6 x 20-30 minute presentations to local community groups	**2)**		**($**	**180)**
	SUBTOTAL	**17)**			**$1,530**
2	**Curriculum Development, Planning, and Evaluation**				
2.2	Up to 20 remote planning & curriculum design and development meetings (2 hrs each)	40		($	3,600)
2.6	project team communication and coordination @ 5 hrs/month	50		($	4,500)

2.4	Project evaluation	10		($	900)
	SUBTOTAL	**100)**		**($**	**9,000)**
3	**Site Visits, Workshops/Restorations, Lectures**				
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	24		($	2,160)
3.2	8 weekend workshops (1-2 per quarter) including on-site restoration actions	64		($	5,760)
	SUBTOTAL	**88)**			**$7,920**
	TOTAL LABOR HOURS AND COSTS	**205**			**$18,450**
	Travel per GSA mileage rate	650	0.625	**($**	**406)**
	TOTAL				**$18,856**

3.2	**Additional contracted subject matter speakers**	**6**	**$500**	**($**	**3,000.00)**

Big Valley Band of Pomo Indians - EPA Director Sarah Ryan

Task No.	Task Description PER year	Hours	Rate	Cost
1	**Participation in Community Outreach and Engagement**		**$50**	
1.1	up to 4 x 2-hour local events on project themes and objectives		**($**	-)
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**10)**	**($**	**500)**
1.3	locally focused media production: 2 news stories, edited video presentation (YouTube etc.)	**5)**	**($**	**250)**
1.4	6 x 20-30 minute presentations to local community groups	**2)**	**($**	**100)**
	SUBTOTAL	**17)**		**$850**
2	**Curriculum Development, Planning, Project Management and Evaluation**			
2.2	Up to 20 remote planning & curriculum design and development meetings (2 hrs each)	40	**($**	**2,000)**
2.6	project team communication and coordination @ 5 hrs/month	50	**($**	**2,500)**
2.4	Project evaluation	10	**($**	**500)**
	SUBTOTAL	**50)**	**($**	**2,500)**
3	**Site Visits, Workshops/Restorations, Lectures**			
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	48	($	2,400)
3.2	8 weekend workshops (1-2 per quarter) including on-site restoration actions	128	($	6,400)
3.3	On-site consultations with landowners on water quality & permitting	75	**($**	**3,750)**
3.4	Instruction on water quality monitoring, pesticides, hazardous algal blooms, county and state permitting policies	27	($	1,350)
3.5	Instruction on cultural sensitivity, traditional ecological knowledge, cultural landscapes, culturally significant species	22.5	($	1,125)
3.6	Onsite water sampling and creek assessment	56.25	($	2,813)
3.7	Water sample data entry into Water Quality Exchange (WQX) database	112.5	($	5,625)
3.8	re-assessment of 6 previous sites with simple report on effects of restoration and further recommendations	**120**	**($**	**6,000)**
	SUBTOTAL	**589)**	**($**	**29,463)**
	TOTAL LABOR HOURS AND COSTS	**656**		**$32,813**

DIRECT COSTS

Task No.	Description				
3.3	Laboratory/testing sampling and shipping supplies			**($**	**2,000)**
3.3	Shipping costs for water samples			**($**	**950)**
3.3	Water, plant, and fish tissue testing at outside labs			**($**	**8,000)**
3.6	re-assess previous year sites - water sampling etc.			**($**	**2,000)**
ALL	Travel per GSA mileage rate	650	0.625	**($**	**406)**
	TOTAL DIRECT COSTS:			**($**	**13,356)**
	TOTAL LABOR AND DIRECT COSTS:			**($**	**46,169)**

	INDIRECT COSTS (14.34%)	($	6,621)
	TOTAL	**($**	**52,789)**

FlowWest

Anthony Falzone, Principal

Task No.	Task Description	Hours	Rate	Cost
1	**Community diffusion of innovation**		**$219**	
1.1	up to 4 x 2-hour local events on project themes and objectives			
1.2	cultivation, empowerment and coaching of 5 local opinion leaders			
1.3	locally focused media production: 2 news stories, 2 edited video presentations (YouTube etc.)			
1.4	6 x 15-30 minute presentations to local community groups			
	SUBTOTAL			
2	**Planning**			
2.2	Up to 12 remote planning meetings	18		($ 3,938)
2.8	Up to 8 Consultations with a riparian restoration specialist & curriculum development	16		($ 3,501)
	SUBTOTAL	**34**		**($ 7,439)**
3	**Site Visits, Workshops/Restorations, Lectures**			
3.9	Cobb area watershed geophysical review	16		($ 3,501)
3.10	Field lecture during training workshop	12		($ 2,625)
3.11	Travel time to field site x 6 visits	27		($ 5,907)
	SUBTOTAL	**55)**		**$12,033**
	TOTAL LABOR HOURS AND COSTS	**89)**		**($ 19,472)**
DIRECT COSTS				
	Travel per GSA mileage rate	1260	0.625	($ 788)
	TOTAL DIRECT COSTS:			**($ 788)**
	TOTAL LABOR AND DIRECT COSTS:			**($ 20,260)**

TRIBAL ECO RESTORATION ALLIANCE - Lindsay Dailey (Director) and Staff

Task No.	Task Description - PER year	Hours	Rate	Cost
1	**Community "diffusion of innovation"**		**$90**	
1.1	up to 4 x 2-hour local events on project themes and objectives			($ -)
1.2	cultivation, empowerment and coaching of 5 local opinion leaders	**10)**		($ 900)
1.3	locally focused media production: 2 news stories, 2 edited video presentations (YouTube etc.)	**5)**		($ 450)
1.4	6 x 15-30 minute presentations to local community groups	**2)**		($ 180)
	SUBTOTAL	**17**		**($ 1,530)**
2	**Curriculum Development, Planning, Project Management and Evaluation**			
2.2	Up to 20 remote planning & curriculum design meetings (2 hrs each)	40		($ 3,600)
2.4	evaluation	10		($ 900)
2.6	project team communication and coordination @ 5 hrs/month	50		($ 4,500)
2.8	On-site consultations with landowners for restoration innovations (including prep for mini plans)	48		($ 4,320)
2.9	mini stewardship plans; map, treatment plans, plant lists	48)		($ 4,320)
	SUBTOTAL	**148)**		**($ 13,320)**
3	**Site Visits, Workshops/Restorations, Lectures**			
3.1	10 site evaluation visits (3 full days @ 3-4 sites/day)	($ 24)		($ 2,160)

3.2	Participation in 8 weekend workshops: Instruction on cultural sensitivity, beaver analogs, bank stabilization, invasive spp removal, cultural burns (programmed and ad hoc), field coordination	64		($	5,760)
3.2.1	Onsite labor for restoration & stewardwship innovations;loading, unloading, inventorying, rehabbing / cleaning tools; team briefings	296		($	26,640)
	SUBTOTAL	**384)**		**($**	**34,560)**
	TOTAL LABOR HOURS AND COSTS	**549**		**($**	**49,410)**
DIRECT COSTS					
3.2	UTV, Dump trailer, Water Bufflao (per day)			($	860)
3.2	Field supplies			($	1,000)
ALL	Travel (GSA mileage @ $0.625/mile, estimated 200 miles)20 trips@65	1300	0.625	($	813)
	TOTAL DIRECT COSTS:			($	2,673)
	TOTAL LABOR AND DIRECT COSTS:			**($**	**52,083)**

Contact Information:
Eliot Hurwitz, Director, Seigler Springs Community Redevelopment Association SSCRA

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ADDENDUM: Cobb Mountain Watershed Education and Restoration Program

how the project addresses BRC-approved requirements

Primary Requirements:

1. Does the project contribute to improving the physical and biological health of Clear Lake? Yes. **How?** The project will build on successful upstream co-management partnerships to restore key watershed lands by establishing best watershed stewardship practices. This will initiate downstream improvements in water quality and quantity that will improve the overall health of the Lake.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? Not yet - as specific on-site locations for program work are identified, we will provide baseline conditions and goals.

3. How does the project demonstrate progress towards achieving the Committee's vision? By involving significantly deeper participation in Lake restoration activities by a larger segment of the watershed community. This effect will be long term and ongoing, building year on year.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)? Tribal partners have been at the core of the current project design. As specific project site(s) are established, tribal members will provide core curriculum and program design guidance.

5. How will the fully implemented project be maintained in the long-term with the local community? The entire premise of this project revolves around deep capacity building and participation from the local community. The project will focus on establishing functioning committees necessary to continue this work as well as a series of specific demonstration projects that can serve as models throughout the watershed.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy. - The project will directly address how improvements to the watershed are inextricably connected to the overall values, goals and strategies of the community.

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in. The project will work intensively with existing community forums including the Cobb Area Council, especially its Forest Stewardship Committee, as well as local Firewise community organizations and every local civic group including local churches, the Cobb Mt. Lions Club, Friends of Boggs Mountain, etc, to involve the total community in understanding of and involvement in project priorities.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies. As each specific on-the-ground project has been identified, any necessary permits will be obtained by project administrators, working with landowner partners.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes: This project is based on work in rural community development pioneered at Ohio State (Flora and Flora 2008) that identified how successful communities leverage key community *capitals* (financial, built, social, human, cultural, natural, political and human). See also University of Nebraska studies. The project also incorporates research on "Asset Based Community Development" (ABCD) amply documented by the ABCD Institute at DePaul University. The current project combines these well established community development modalities with existing studies of Traditional Ecological Knowledge (TEK). See, for example this study from the US Forest Service on "The Role of TEK in Climate Change Initiatives." The [program has also already built a significant reference binder filled with technical studies and references on best riparian stewardship practices.

10. Use existing data to the maximum extent feasible OR describe specific data gaps expected to be filled through project implementation. The project will make use of existing data from USGS stream monitoring, especially in Kelsey and Adobe creeks as well as water quality monitoring data from BVBPI/EPA. However, the project will also develop additional data for upstream creek sites.

11. Describe the proposing entity's experience on similar projects. SSCRA has been the administrative manager for the current cycle of the WERP program, managing the $130K scope for 2022-2023. SSCRA has been active in the Cobb Mt. community since 2016, managing $800K in grants from local, state and private foundation sources. The nine members of the project core team have extensive experience in riparian ecology, water and limnological science, Tribal culture and TEK, and community engagement.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.). The core issue being addressed by this project - building new co-stewardship partnerships between Tribes and existing land owners, is not within the scope of any existing statutory or regulatory framework and has not been previously addressed because it depends on deep grassroots organizing that can be coordinated with a culturally informed educational and action-oriented program of site-specific eco-rehabilitation projects.

Clear Lake Blue Ribbon Committee

Keys POA: Revitalization and Restoration Planning and Design for the Clear Lake Keys

JANUARY 17, 2023

Project Description: The Clear Lake Keys Subdivision (hereafter "the Keys") is located on the southeast shore of Clear Lake, approximately 100 miles north of San Francisco (Figures 1 & 2). The Clear Lake Keys Property Owner's Association (POA) was organized in 1989 and currently involves all 942 property owners in the Keys. The original intent of the POA was to control what was emerging as the leading threats to the ecological health and quality of life of the Keys: invasion by non-native Creeping Water Primrose (*Ludwigia peploides*), and sedimentation of the Keys channels due to upstream land uses that did not implement proper sediment control measures (Figure 3). These changes largely destroyed the ecology of Schindler Creek, reducing the cover of native riparian vegetation, and eliminating spawning habitat for Clear Lake Hitch (*Lavinia exilicauda chi*), a species of critical importance to local Native American Tribes and a candidate species for listing under the Endangered Species Act.

Despite numerous attempts over the last 30 years, a coordinated response to the *Ludwigia* and sedimentation problem has remained elusive due to the complexity of permitting across multiple government agencies, budgetary constraints, and personnel turnover and burnout. The social and economic impact has affected the Keys by decreased property values and tax revenue, loss of recreation and boating access, elimination of fish and wildlife habitat, decreased tourism, increased health problems, and decreased overall quality of life. The results of this degradation are also clearly visible from CA-20, creating a well-known eyesore to everyone driving by. Tragically, Clear Lake Hitch also no longer spawn in Schindler Creek.

In addition to restoring Schindler Creek, we found evidence that approximately 0.5 mile of historic streamchannel has been diverted onto the Keys boat ramp (Figures 4 & 5) likely due to CalTrans highway maintenance, that appears to have eliminated wetlands and wildlife habitat in the area southeast of the Keys known as the Shannon Ranch (Figure 6), an area of historic importance to the local Elem Indian Colony. The concrete drainage ditch along CA-20 currently empties into a dirt channel that is discharging sediment into the Keys without the benefit of an armored spillway, culvert, or any kind of outfall structure (Figure 5). By restoring the natural route of this watercourse we can eliminate this source of sediment to the Keys, and restore Elem Indian Colony ancestral wildlife, hunting, foraging and fishing grounds.

Finally, by removing *Ludwigia* and improving circulation, this project will address the stagnant water that was identified by Lake County Vector Control District as mosquito breeding habitat. Five cases of West Nile Virus were detected in September 2022, and due to an abundance of primrose and algae, boats were unable to enter into the Keys channels to effectively spray for mosquitoes during 2022.

We now have a rare opportunity to combine *Ludwigia* control with sediment removal, restoration of habitat for Clear Lake Hitch and game fish such as bass and crappie, elimination of breeding habitat for vectors of West Nile Virus, improvement of recreational values for residents of the Keys, and reestablishment of previously eliminated wetlands and watercourses back onto historic Elem Indian Colony lands. The proposed project will occur in four phases over five years. The project will increase the quantity and quality of wetland habitat and open water along 5.2 miles of channels within the Keys, plus 1.2 miles of State-owned and County-

entrusted channel within the Keys, affecting 942 property owners. This project will also recreate 0.5 miles of streamchannel and approximately 20 acres of wetland and wildlife habitat on the Shannon Ranch.

Phase I: *Ludwigia* Control, Engineering Planning, Hydraulic Modeling, Grant Writing, Permitting (Years 1-2): This phase will remove *Ludwigia* from all physical channels in the Keys as well as Schindler Creek. Numerous control methods for *Ludwigia* have been used successfully including manual removal and herbicide treatments. An Invasive Species Removal & Monitoring Plan will be prepared that will incorporate best practices from restoration practitioners working in the region that have experience with *Ludwigia* control methods. Next, riparian vegetation including native tule (*Schoenoplectus* spp.) and willows (*Salix* spp.) will be reestablished throughout the project area. A Native Species Revegetation Plan will be developed in coordination with local restoration practitioners including Luis Santana (Robinson Rancheria Environmental Center) and Benjamin Huffer (CDFW) that have experience with revegetation using tule. Phase I is anticipated to begin in spring/summer 2023 and will likely require permitting in the form of Statutory Exemptions for Restoration Projects (SERP) authorization. In this phase we will also (a) retain qualified professionals to perform hydrological modeling and prepare initial engineering drawings for channels and sediment basins, (b) submit planning and implementation watershed restoration grants to CDFW, (c) initiate permitting in the form of SERP/CEQA authorization for activities in this and subsequent phases.

Phase II: Schindler Creek Sediment Removal & Channel Restoration, CEQA Permitting (Year 3): This phase involves removal of sediment with an excavator and dump truck from impacted reaches of Schindler Creek (e.g. Figure 3), and restoration of the geomorphology of the channel in several places. This phase will require SERP authorization for the work related to Schindler Creek. For this phase both the CDFW planning and implementation grants will have been awarded (although not yet necessarily disbursed; see below for more information on cost sharing). This phase will also involve continuation of CEQA permitting for the removal of sediment in the remainder of the Keys minus Schindler Creek in phase III.

Phase III: Keys Sediment Removal & Sediment Basin Construction (Year 4): This phase involves sediment removal from the rest of the Keys. Authorization from CEQA (or SERP) will have been awarded by this point. Sediment will be disposed of at an approved site, and previous studies performed by CH2MHill identified the EPA Sulphur Bank Mine cleanup site as a potential recipient for the sediment, to be used as capping material. This conversation with the EPA will be reinitiated as part of this project. Also part of this phase will be construction of one or more sediment basins to trap stormwater during high runoff events. This basin is intended to be constructed near the Dollar General store to the north of CA-20, to intercept sediment before it enters the Keys. Depending on the results of hydraulic modeling and engineering calculations, culverts may also be installed to improve circulation between different channels within the Keys.

Phase IV: Restore CA-20 Drainage to Natural Channel, Restore Wetland & Riparian Habitat (Year 5): This phase is contingent on a collaborating agency or entity acquiring controlling interest in parcels to the southeast currently known as the Shannon Ranch (Figure 6). This project will remediate the damage caused by the drainage ditch that currently flows through a linear unprotected channel and deposits sediment from the highway over the side of the boat ramp and into the Keys without the benefit of any kind of protected outfall structure (Figure 5). This project will involve rerouting of the drainage ditch to its original route via a naturally meandering channel crossing the field and wetland complex immediately to the southeast of the Keys (Figure 6). This complex has potential to be acquired by Lake County Land Trust and is part of Elem Indian Colony ancestral lands. Reestablishing the approximately 0.5 miles of lost streamchannel and reconnecting the channel with Clear Lake has the potential to increase wildlife and wetland habitat, and make available to the Elem Indian Colony over 80 acres of their ancestral land.

Project Timeline: As described in more detail above, the project is broken into four phases over five years. In summary, the major project tasks are intended to be completed as follows:

Phase	Year 1	Year 2	Year 3	Year 4	Year 5
I: *Ludwigia* removal, planning, permitting	X	X	X		
II: Sediment removal, permitting			X	X	
III: Sediment removal, basin construction				X	X
IV: Shannon Ranch restoration					X

Projected Budget: The following represents a rough breakdown of the projected costs of the Blue Ribbon Committee portion of implementing the project. As described in *Cost Sharing*, below, Blue Ribbon Committee funding will be used to supplement two CDFW watershed improvement grants (planning and implementation), and to cover the portion of the sediment removal not covered by the CDFW grants. We are also actively soliciting additional sources of funding and will continue to do so throughout the life of the project.

Task	Cost ($)
a. Project & Agency Coordination	100,000
b. Planning & Grant Writing	200,000
c. SERP & CEQA Permitting	400,000
d. Engineering Design & Hydrological Modeling	500,000
e. *Ludwigia* & Sediment Removal & Revegetation in the Keys (minus Schindler Creek), Sediment Basin Construction	1,100,000
TOTAL	**2,300,000**

Contact Information:

Christopher T. DiVittorio, PhD
Pinecrest Research Corp., Inc.
(510) 881-3039
chris@pinecrestenvironmental.org
www.PinecrestEnvironmental.org

Angela De Palma-Dow
Water Resources Department, County of Lake
(707) 263-2344
255 N. Forbes St. Lakeport, CA 95453

Edward Legan, President
Clear Lake Keys Property Owners Association
(702) 497-8938
info.keyspoa@gmail.com
www.keyspoa.com

Cost Sharing: As discussed at the multi-agency meeting on January 11, 2023, there are numerous opportunities for supplemental funding for portions of this project. Most notably, the CDFW watershed rehabilitation grants program has encouraged us to apply for a planning grant to support grant writing, permitting, and engineering design. A second subsequent implementation grant will be submitted to fund the actual *Ludwigia* control, sediment removal, and revegetation for the portion of the project that involves Schindler Creek. This grant will also presumably fund some of the restoration of the watercourse on the Shannon Ranch, although we intend to apply for other funding for this portion of the project including from private foundations and the Federal government.

Coordination & Consulting: Coordination across multiple state and local agencies is now ongoing, and several specialty consulting and restoration companies have been retained, some on a *pro bono* basis due to their belief in the importance of this project for the region and for the Clear Lake Hitch. Dr. Christopher DiVittorio

from Pinecrest Research Corp. is coordinating a group of consultants and assisting with biological reporting and grant writing. WRA Associates are in the process of being contracted for SERP/CEQA permitting and external grant writing. In addition, Dr. DiVittorio is currently in contact with hydrologists and engineers and will have a technical team assembled shortly.

Stakeholder Participation: We will continue to seek partnership with all other interested stakeholders including County of Lake Water Resources and Vector Control, EJ Crandell (Board of Supervisors Chairman/District 3), Luis Santana (Fisheries, Robinson Rancheria Environmental Center), Elem Indian Colony of Pomo Indians, Habematolel Pomo of Upper Lake, Big Valley Rancheria, U.S. Environmental Protection Agency (USEPA), California Department Fish & Wildlife (CDFW), Lake County Land Trust, and Lake County Natural Resources Conservation Service (NRCS). We will also be working in coordination with the California Department of Food & Agriculture (CDFA) Hydrilla Program and USEPA Superfund Site cleanup teams to prevent impacts from Hydrilla (*Hydrilla verticillata*) invasion or mercury/arsenic contamination.

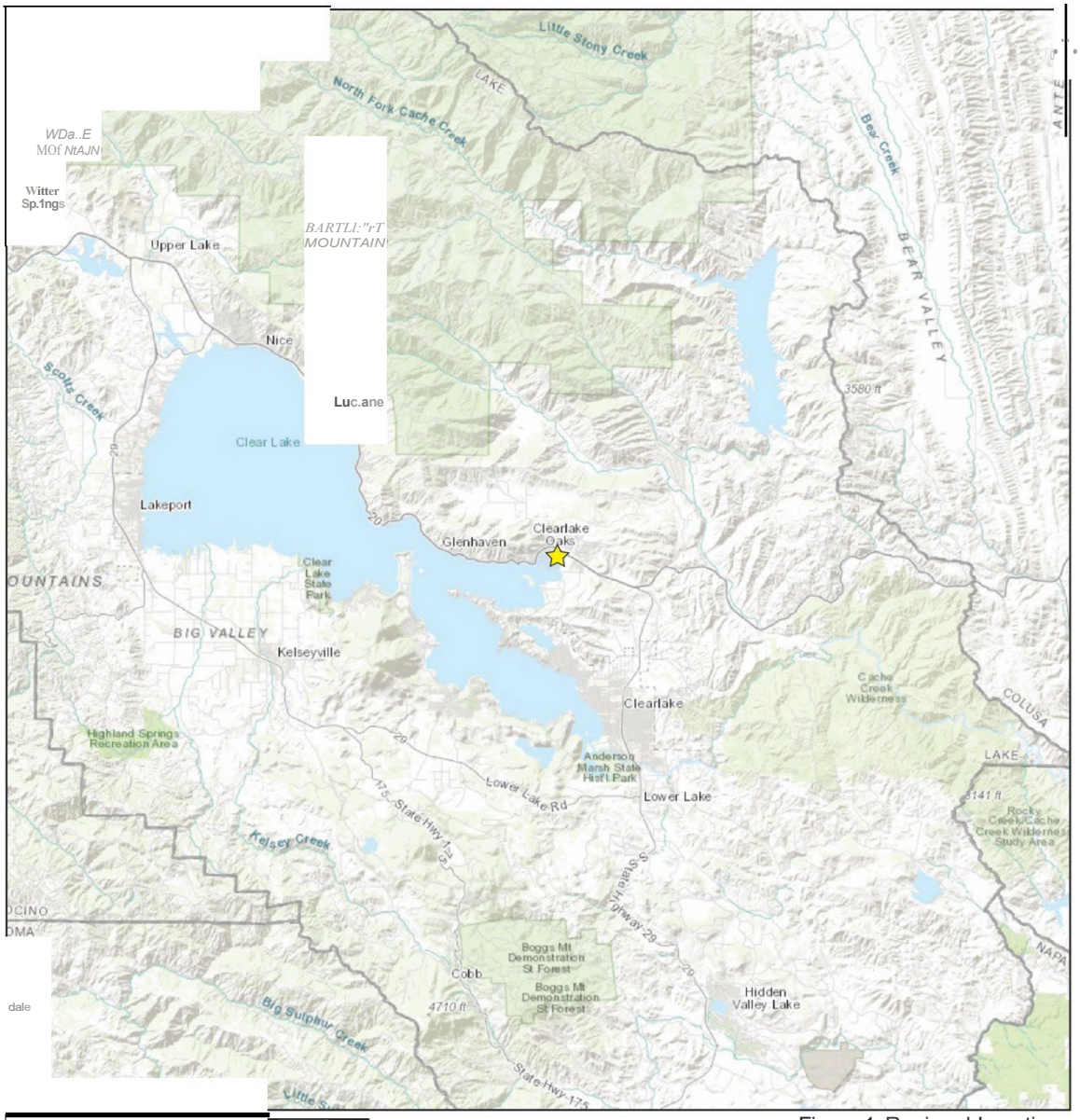

Figure 1: Regional Location

Project Site

SOURCES: California Dept. of Fish & Wildlife (CDFW)

Figure 2: Topographic **Map**

Pinecrest Research Corporation
pinecrestenvironmenta1.org

A

2000feet

Clearlake Keys Property Owner's Association Area

SOURCES : USGS

Figure 3: Photograph of Schindler Creek below Konocti **View** Bridge

Figure 4: Photograph of CA-20 Drainage Ditch (South of CA-20)

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orporation
pinecrestenvironmental.org

SOURCES: PEC Inc.

Figure 5: Photograph of Unprotected Outfall from CA-20 Drainage Ditch

Pinecrest Research Corporation
pinecrestenvironmental.org

N

500 feet

- Existing Drainage Ditch
uu11 Proposed Restored Creek:
)-(Culvert
- Existing Wetlands (approximate)
Potential New Wetlands

SOURCES:Google Earth: PEC Inc.

Revitalization and Restoration Planning and Design for the Clear Lake Keys

Letter of Support for Keys Revitalization Proposal- East Region Town Hall

December 16, 2022

To:
Lake County Board of Supervisors
255 N. Forbes St, #109
Lakeport, CA 95453
Attn: Clerk of the Board of Supervisors

Lake County Blue Ribbon Committee
s.magill@csus.edu
Attn: Sam Magill

Clearlake Oaks Keys POA
P.O. Box 1329
Clearlake Oaks, CA 95423
Attn: Ed Legan

Re: Resolution of support for proposals to study and rehabilitate Clear Lake pollution areas in the Keys watershed canals.

The East Region Town Hall (ERTH) has considered proposals and comments provided to the Blue Ribbon Committee's (BRC) Technical Subcommittee and supports the proposal by the County of Lake Water Resources Division including comments by the technical subcommittee to restore important lake attributes in the Keys canals and watershed processes. The proposed project is in keeping with the charter and intent of the BRC.

ERTH is a legal Municipal Advisory Council established by the Lake County Board of Supervisors under Gov. Code Section 31010 to advise on matters of public health, safety, welfare, public works, and planning for the County unincorporated areas in the Clear Lake Oaks arm of the lake.

The Keys canal area is a subdivision of Clearlake Oaks that traditionally hosted a Pomo village site dating back millennia. Today the Keys is a community development neighborhood of over 850 properties that was designed before modern project review and environmental laws and was originally built on a wetland delta formed by Schindler Creek (~circa 1960). Lost in this development was a significant natural wetland that supported lake natural processes. This was similar to the wetland processes lost for the lake in the Middle Creek wetland conversion to farming. These processes are key components to the restoration of Clear Lake.
The lake is compromised by, habitat loss, pollutants and cyanobacteria blooms which create reduced aquatic health, noxious odors and toxic conditions. Home owners, the water district and tourism are directly affected by the situation.
The restoration of lake processes in the Keys canals will benefit Clear Lake through permanent removal of invasive aquatic plants, polluted sediments that contain road and farmland toxicants, natural phosphorus nutrients that support cyanobacteria blooms and sediments that block passage of historical hitch fish species significant to the local tribes. Restoring attributes such as water

depth, aquatic emergent vegetation, spawning and rearing habitats, lake flow and upslope stability will improve many positive lake functions and develop an aquatic habitat important to the lake ecosystem and restore high quality lake use by local citizens.

Sincerely,

Denise Loustalot, Chairman East Region Town Hall
James Burton, Vice Chairman East Region Town Hall
Pamela Kicenski, Committee Member East Region Town Hall
Tony Morris, Committee Member East Region Town Hall

Letter of Support for the Keys Revitalization Proposal- Lake County Land Trust

The Lake County Land Trust protects land and water resources of important value on behalf of present and future generations. We work to sustain our county's environmental, scenic, cultural, and historical integrity.

Feb. 23, 2023

To: Blue Ribbon Committee for the Rehabilitation of Clear Lake

The Lake County Land Trust fully supports the Clearlake Oaks Keys Revitalization and Restoration Project. This proposed project should improve water quality and fish and wildlife habitat in the Keys area of Clear Lake Oaks which will add to the overall health of Clear Lake.

The Lake County Land Trust would consider assisting in the acquisition and protection of the neighboring wetland parcel, to the east of the Keys, which is currently the location of a nesting area for both Great Blue Herons and Black-crowned Night Herons, along with other birds and waterfowl. The Land Trust understands the aim of the project is to restore and protect the natural shoreline of the Clearlake Oaks arm of Clear Lake. The project would also improve the condition of the Clearlake Keys channels, historically a marshy wetland.

Please support the Property Owners Association in its efforts to restore the Clearlake Oaks Keys by approving this project as presented to the Blue Ribbon Committee.

Thank you for your consideration.

Sincerely,

Valerie G. M. Nixon

President, Lake County Land Trust

Letter of Support for the Keys Revitalization Proposal- US EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9
75 Hawthorne Street
San Francisco, CA 94105-3901

March 9, 2023

Angela De Palma-Dow
Water Resources Department, County of Lake, CA
255 N. Forbes St. Lakeport, CA 95453
Via Electronic Mail

RE: Clearlake Keys dredging project

Dear Ms. De Palma-Dow:

Thank you for your recent participation in the Sulphur Bank Mercury Mine OU-1 Proposed Plan Open House. As we discussed, the cleanup of the portion of the site that includes the mine itself (Operable Unit 1, OU-1) is expected to require a large quantity of clean soil/fill earth to construct caps/soil covers over areas of contamination and mine waste. All viable cleanup approaches include some degree of capping, so this will be the case regardless of the specific cleanup alternative eventually selected in the Record of Decision.

In EPA's Proposed Plan for OU-1, the presumed method of bringing capping material to the site is via roadway hauling because EPA depended upon existing and available sources of soil for scoping and evaluation of alternatives. However, because the hauling of capping material to the site by truck has significant community, environmental and cost impacts in the forms of traffic, road noise, vehicle emissions, etc., projects with the potential to provide capping material without significant road-based hauling will be of particular interest to EPA. The community further reinforced this point in recent public meetings held by EPA during which the trucking of material to the site was raised as a serious concern. Community members have requested that EPA evaluate all means of reducing trucking of material over local roadways.

In 2009, EPA's contractor CH2M Hill composed a technical memorandum evaluating the possibility of using dredged sediments sourced from the Clearlake Keys in the construction of the caps anticipated as part of the Sulphur Bank remedy. Based on the data available to them at that time, they concluded that dredged sediments from the Keys appeared to meet certain basic chemical and physical parameters required for use in terrestrial caps at the site. They recommended that the use of this material be given more detailed evaluation during the Remedial Design process (the detailed engineering design step that follows the Record of Decision but precedes actual remedy implementation). EPA has recently published the Proposed Plan for the OU-1 cleanup and therefore is hopeful that the Remedial Design process could begin as soon as 2024.

I understand that a proposal is being drafted for the dredging of the Clearlake Keys. As the disposal of dredged sediments is often a significant consideration for projects of this sort and because dredged sediments can generally be transported via barge or pipeline, I wanted to share these facts for consideration by your agency and any other party reviewing such a proposal.

If you have any questions or concerns please feel free to contact me at (628) 223-3524 or jessop.carter@epa.gov.

Sincerely,

Carter Jessop
Superfund Remedial Project Manager

Letter of Support for the Keys Revitalization Proposal- Redbud Audubon Society

Redbud Audubon Society

March 6, 2023

To: Blue Ribbon Committee for the Rehabilitation of Clear Lake

Redbud Audubon fully supports the Clearlake Oaks Keys Revitalization and Restoration Project. This proposed project should improve water quality and fish and wildlife habitat in the Keys area of Clear Lake Oaks which will add to the overall health of Clear Lake.

The Clearlake Oaks Keys is an important bird area and currently is a nesting area for Great Blue Herons, Double-crested Cormorants, Black-crowned Night Herons, Osprey and many other birds and waterfowl.

Redbud Audubon understands the aim of the project is to restore and protect the natural shoreline of the Clearlake Oaks arm of Clear Lake. The project would also improve the condition of the Clearlake Keys channels, historically a marshy wetland.

Please support the Property Owners Association in its efforts to restore the Clearlake Oaks Keys channels and the wildlife habitat they provide by approving this project as presented to the Blue Ribbon Committee.

Thank you for your consideration.

Sincerely,

Roberta Lyons

Roberta Lyons

President, Redbud Audubon Society

Robinson Rancheria Environmental Center, in collabora4on with Lake County Water Resources, and Tribal Eco Restora4on Alliance, are par4cipa4ng in replan4ng of tules near Clarks Island in the Oaks Keys.

The purple is the proposed willow staking for Fall 2023, while the green is tule replan4ng. With the very wet 2022-2023 winter we're hoping a lot of tules pop out where they once were. Some talks have taken place to try and fence off some of those tules to keep out Carp and Goldfish in the hopes of keeping roots intact. Willow staking would most likely take place early December when willows are dormant.

This last winter we staked willows on one side of a pond at Robinson Rancheria and all of them took and bloomed. We plan on watering once a month in the summer as they should be able to survive naturally in the area since they are a na4ve species and can handle local drought condi4ons. We plan on doing the same at the Keys where available this next fall in the green areas in the map above.

Clear Lake Blue Ribbon Committee

Clear Lake Management Plan Development

January 12, 2023

County of Lake Watershed Protection District: Clear Lake Management Plan Development

Project Description:

Proposed by: Lakebed Management, Water Resources, Watershed Protection District
Including past efforts, current efforts, future/ planned efforts and remaining knowledge gaps or management programs to improve Clear Lake

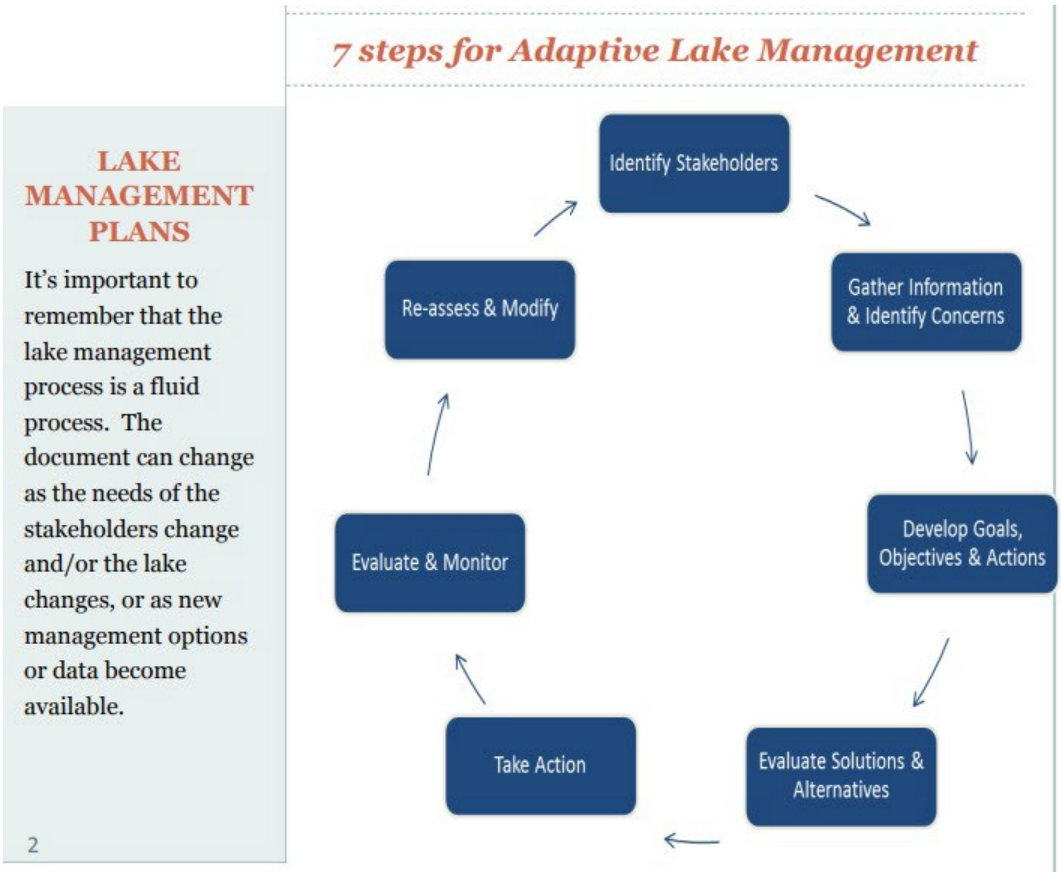
This project would supplement an update to the Clear Lake Integrated Watershed Management Plan and would add a specific chapter: Lake Management for Clear Lake. This plan would complement and support other existing plans and plans being written such as TMDL attainment plans, Source Water Protection Plans (2023), Sanitary Surveys (2017, 2023), Stormwater Management Plans (2008, 2024), Hitch Conservation Strategy Documents, and Clear Lake Basin Watershed Assessments (2023).

This plan would be a collaborative effort, and utilize a neutral contractor to write and develop the plan with input from the community and project partners (including Blue Ribbon Sub Committees). This proposal includes funds to select a contractor for writing services and a facilitator to coordinate and execute the effort, along with funds to provide for participating agencies and partners.

This document has many objectives, included but not limited to:

- Identified goals & action items for purpose of improving, protecting, and maintaining a desired condition Clear Lake at a given time.
    - Dynamic Document!
    - Co-Management Concept, as the lake doesn't belong to one agency
    - This desired conditions, or target goal, will be a large part of the development of this plan
- Supplement future Watershed Management and Basin Plan Updates
- Describe lake activities (past, current and future efforts)
- Describe contributors/influences to lake *quality and quantity*
- Identify knowledge gaps, and missing information
- Reference for all lake-related research, data, information or where to find these resources
- Most importantly, this plan will be publicly accessible and interactive, and not just a stale binder on a shelf in a non-descript government building.

The development of this plan will follow the North American Lake Management Society (NALMS) framework for Adaptive Lake Management:



Graphic Source: Lake County, IL Lake Management Planning Guide https://www.lakecountyil.gov/DocumentCenter/View/23814/Lake-Management-Planning-Guide-Workshop_22418?bidId=

Specific Sections of the plan will include the following topics (and more!):

- Lake information (depth, size, watershed, development, etc)
- Aquatic species management
- Aquatic invasive species management/control
- Wildlife/fishery management
- Nutrient budgeting, nutrient trends over time
- Shore protection
- Lakebed Management
- Water quality monitoring and protection
- Authority of Management, Community, Co-Managers
- Recreational management
- *Watershed management* (briefly, with tie in to previous and future updated Integrated Watershed Management Plan)
- Blue Ribbon Committee programs & projects, activities current and anticipated
- Benchmarks to evaluate management progress

Success will be when a document is completed, with community and partner input, that meets the needs of the Blue Ribbon Committee and Lake Managers from County, State, Tribes, Cities, and partner organizations.

Project Timeline:

Timeline for project.

- **Year 1:** Grant Administration for start-up, RFP and Contracting with writing consultants and facilitation support
- **Year 2:** Plan Development including outreach and collaborative input
- **Year 3:** Plan Completion, Reporting, and Presentations to Boards, Councils, and BRC.

Projected Budget:
Overall budget request: $168,000
With County Contribution: $16,500
Total Project Costs: $184,500

Budget would include:

- Facilitator, researcher, writer
- Data Analysist, Spatial analyst team, hydrologist (quantity)
- Agency, Co-management, Community Engagement and facilitation support
- Funds to include agencies, departments, organizations participation in development and review process
- Lake County can contribute towards overages of estimated budget

Task	CNRA funds	Contribution (LCWRD)	Total project Costs
1.0 Project Coordination, reporting	$15,000	$7,500	$22,500
2.0 Consultant: Facilitator, research, writing, document compilation, data collection, project development	$125,000		$125,000
3.0 County staff participation & travel	$8,500	$4,250	$12,750
4.0 External agency contribution, participation, travel, space rental	$9,500	$4,750.00	$14,250
5.0 Outreach public engagement	$10,000		$10,000
Total BRC Grant Funds Requested	**$168,000.00**	**$16,500**	**$184,500**

Contact Information:

- Angela De Palma-Dow, Lake County Watershed Protection District, Angela.DePalma-Dow@lakecountyca.gov, (707)263-2344, 255 N. Forbes St. Lakeport, CA 95453

Additional Information:

Any overages in project costs will be supported by Lake County Watershed Protection District

Addendum: Clear Lake Management Plan Development Addendum to Address Committee Proposal Requirements

Contact: Angela De Palma-Dow, County of Lake Water Resources Department, Angela.DePalma-Dow@lakecountyca.gov

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

Yes, by compiling all the lake management activities in one place, with collaboratively identified lake management actions and priorities, the project will make future efforts more effective and efficient, eliminate duplication and unnecessary tasks. This document will incorporate adaptive co-management, which is iterative and will respond and adjust according to pre-determined metrics and criteria that identify if lake management actions are improving physical and biological health of the lake.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

Yes, by outlining current programs, projects, and efforts, and their outcomes (or where to find their outcomes) to describe the current state / condition of the lake and results of current or past management. Then this document will specifically identify and list remaining goals, products, and outputs that are needed to reach desired conditions as established by those parties collaboratively contributing to the document.

3. How does the project demonstrate progress towards achieving the Committee's vision?

Part of AB 707 goals is to *"identify barriers and contributing factors to the poor water quality, strategies to improve the water, and the threats to wildlife….[and] recommendations and plan for coordinating with local, state, [tribal] and federal governments to secure funding for implementation of restoration activities."*
This project meets those goals directly as the definition of a Lake Management Plan, according to North American Lake Management Society (NALMS), *"is a dynamic document that identifies goals and action items for the purpose of creating, protecting and/or maintaining desired conditions in a lake and its watershed for a given period of time. Each lake management plan is different, depending on the conditions of the lake (watershed) and the interests of the stakeholders involved. A lake management plan also provides a framework for future lake boards & users as to what issues have been addressed and how successful previous efforts were."*
The development of the Clear Lake Management Plan will follow guideline of NALMS, and include BRC visions as one of the main tenants.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

The seven tribes will each be invited to participate in the creation of the plan; to be specific the proposal includes a facilitator and writer to complete the actual, physical "plan", and to conduct the participation shareholder meetings that will contribute to the content of the plan, provide reviews of already written content, and provide updates for past, current, and future projects that are relevant to the plan. Tribal representatives will be contacted to and invited to participate to the plan development and if they are unable to do so, alternative accommodations will be prioritized.

We will be relying on the BRC facilitator and chair to assist so that we are able to fully incorporate tribal co-management into the plan.

5. How will the fully implemented project be maintained in the long-term with the local community?

This plan is not an implementation project, however projects, priority actions, and tasks that are identified in the plan will include responsible parties, if applicable, and identified partners. The plan will also help to direct future grant projects, prioritize and direct resources at the local level. Having projects prioritized and outlined in one place, will help the local community be more efficient at tackling complex solutions relating to lake improvement.

<u>Secondary Requirements.</u> To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.

As established in the text of AB 707, projects "aimed at cleaning up the lake for environmental gains that will revitalize its regional significance so that it may once again be used for recreational purposes, thus creating jobs and inciting new economic development." The Lake Management Plan, as stated in Q1, will address this "Lake Cleanup" by improving the physical, biological integrity and health of the lake by outlining plan, projects, and programs needed to reach specific and desired benchmarks.

As the BRC may already know, but a vibrant, usable Clear Lake is a cornerstone to a strong Lake County economy, and improvements to Clear Lake WQ will correspond with improved water access, reduced drinking water rates, increased tourism and water-based recreation opportunities, which all are important to local economic sector.

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.

As described in Q 4 above, proposal includes a facilitator and writer to complete the actual, physical "plan", and to conduct the participation shareholder meetings. These meetings will include public town halls, interagency workgroups, publically accessible webinars, lectures, outreach events, and others as needed to communicate the need for and purpose of the plan to the community – both through in person, virtual, print, and audio formats.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.

This project does not require any permitting, however within the document for identified high priority implementation or construction projects, the necessary permits and requirements will be identified, outlined, with any additional necessary information to best understand the full scope of project for future planning purposes like grant funding research.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

A significant part of this plan will include a summary and description of past and future work that has been done on and in Clear Lake to best set up the background needed to complete the rest of the plan. As described in step 2 of the NALMS steps for Adaptive Lake Management (*Lake County, IL Lake Management Planning Guide* *https://www.lakecountyil.gov/DocumentCenter/View/23814/Lake-Management-Planning-Guide-Workshop_22418?bidId=*), is "Gather Information and Identify Concerns". Additionally, as described in our proposal brief previously, major components of the plan include topics that describe the current lake and conditions, physically, biologically and chemically, which are mostly based on findings of future research and past outcomes. This plan will better inform future efforts by putting all lake management information in a single, easy to use resource

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

Please see above answer to Q9. A direct outcome will be identification of data gaps and required actions to address those. A Lake Management plan could help guide and inform decisions as they relate to funding and priority.

Imagine if we had a Lake Management Plan prior to research starting as part of the BRC efforts – we would have a clearer roadmap to work that was or is being completed and what information was most needed going forward.

11. Describe the proposing entity's experience on similar projects.

The contact and lead for this project is currently managing ~$6 million in grants, some implementation and some planning. The proposing entity (Water Resources Department) was the project lead on the development of the 2010 Clear Lake Integrated Watershed Management Plan, the Subwatershed Plans for Scotts, Kelsey, and Middle Creek, and contributed to the plan development of the Westside Integrated Regional Water Management Group with Yolo, Napa, and Solano County.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why

the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

This plan is not required under and existing statutory or regulatory responsibility.

Clear Lake Blue Ribbon Committee

County of Lake Watershed Protection District: Continuation of Limnological Sampling Clear Lake, CA

January 2023

Project Title: Limnological Sampling Clear Lake, CA (*Continuation, part 2,…)*

Project Description:

Continuation of monthly ambient monitoring of Clear Lake in all three arms as part of the Clear Lake Ambient Monitoring Program (CLAMP). Since 1968, the California Department of Water Resources (DWR) has conducted ambient water quality monitoring and sampling of Clear Lake in 3 locations: the Upper, Lower and Oaks arms of the lake. Data derived from this sampling allows the State, County, Tribes, and other impacted local organizations to identify and track key nutrients and potential contaminants. This publicly available water quality information is essential for making water quality management decisions for Clear Lake and dependent downstream areas, including the Cache Creek Watershed and ultimately, the California Delta.

Due to funding shortages in 2020, DWR terminated their monthly ambient water quality monitoring program in Clear Lake. County of Lake Water Resources Department (i.e. Watershed Protection District, herein "Lake County")) has continued an abbreviated monitoring program in the lake, although this is a burden on a department located in a disadvantaged community that does not receive general funds.

A relatively small investment in a consistent water quality monitoring program has significant management and research implications. Without some assistance, the valuable information collected from this program, which is vital to the success of any actions produced by the Blue Ribbon Committee, will be lost and impossible to attain. This loss will likely impact not just Lake County water quality management efforts, but also the 17 Public Water Systems and an unknown number of small and private drinking water supply operations around Clear Lake, downstream water users, and the environment.

With general funds, this project will include three major tasks:

1) Project Coordination (Management, Reporting, and Accounting)
2) Water and Sediment Sample chemical Lab Analysis (through Alpha Labs in Ukiah and UC/Davis TERC Labs)
3) Sampling labor and field supplies, and funds to conduct data QAQC and upload into CEDEN/WQX. Field supplies include reagents, calibration materials, buffers, probes, probe replacements, tablet accessories, sample bottles, sampling gear like lifejackets and gloves.

These funds would provide 3 years of continued monitoring support for Lake County, and partners, to continue sampling and analyzing ambient lake conditions for a variety of physical, chemical, and biological parameters.

Project is always open for community involvement and participation, boat and field trips and education. We would gladly take anyone willing to participate in sampling and to see Clear Lake from the middle of the Lake!!

Data from this project is currently stored, and would continue to be stored in CEDEN under the projects:
"Clear Lake Limnological Ambient MP – LCWRD Sampled" and
"Clear Lake Sediment Nutrient Monitoring"
This data also gets transferred to WQX when CEDEN crosswalks are updated to perform this task.

Project Timeline:

Timeline for project. Ideally, break down the timeline by phases. Example below for a multi-year project (your proposal may be shorter term)

- **Year 1:** Grant coordination, Sampling, data consolidation, QAQC and data upload. Reporting.
- **Year 2:** Sampling, data consolidation, QAQC and data upload. Reporting.
- **Year 3:** Sampling, data consolidation QAQC and data upload. Reporting.

Projected Budget:

Funds would go to support sampling staff support, chemical analysis for both water and sediment nutrients, data analysis support for data management, needed equipment, reagents, and field tools, supplies. Funds would also support technical support to QA/ QC Data and upload into state and federal databases (CEDEN and WQX).

Overall Budget amount:

3 year project EstimatedTotal: $512,718
Requested CNRA funds: $452,718
Lake County WPD Match/ Contribution: $68,200

Any overages needed to make this project successful will be sourced from Lake County Water Resources Lakebed Management funds as contribution.

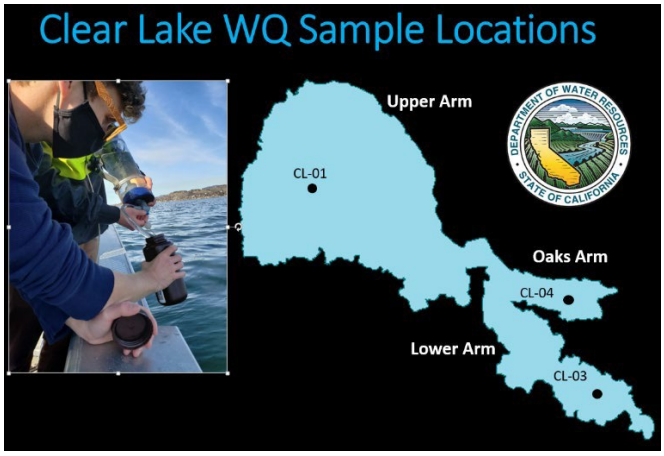
CNRA COST ESTIMATE - PLANNING PROJECTS - Lake County Ambient Limnological Sampling					
Task #	**PROJECT ELEMENTS**	**Estimated Costs**	**General Fund Grant**	**Internal Funds Match (Personnel, Overhead & Indirect Charges)**	**Funding Source (specify)**
	Planning, Coordination, Outreach				
	Deliverables: Task 1.0 Project Management (3 years)				
1.1	Project Management	12,927	12,927		**County Internal Match**
1.2	Project Reporting	2,000	2,000		

1.3	Accounting	3,591	3,591		
	Task Sub Total	**$ 18,518**	**$ 18,518**		
	Assessments and Data Collection (SubContractors)				
	Deliverables Task 2.0 Lab Analysis (sub-contractors)				
2.1	Alpha labs Water nutrients analysis	189,000	189,000		
2.2	UC Davis/ TERC Sediment analysis	150,000	150,000		
	Task Sub Total	**$ 339,000**	**$ 339,000**		
	Deliverables Task 3.0 Sampling labor & Supplies				
3.1	District Labor to conduct Sampling (water & sediment)	135,000	75,000	60,000	**County Internal Match**
3.2	District Labor to QAQC & upload Data	8,200	8,200	8,200	
3.3	WQ instrument Accessories (reagents, buffers, probes, etc.)	12,000	12,000		
	Task Sub Total	**$ 155,200**	**$ 95,200**	**$ 68,200**	
	Grand Total	**$ 512,718**	**$ 452,718**	**$ 68,200**	

Contact Information:

- Angela De Palma-Dow, Lake County Watershed Protection District, (707) 263-2344, Angela.DePalma-Dow@lakecountyca.gov

Additional Information:



Addendum: Limnological Sampling Clear Lake, CA
Addendum to Address Committee Proposal Requirements

Contact: Angela De Palma-Dow, County of Lake Water Resources Department (WRD), Angela.DePalma-Dow@lakecountyca.gov

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

Yes this project directly contributed to improvements in the physical and biological health of Clear Lake by adding to the long-term data record that is needed for managers, researchers, and policy makers to gauge changes over time and improvements made as a result of implemented management actions.

Without the data this project provides, general water quality (WQ) health conditions of Clear Lake would be unknown, making any BRC-funded project, or others, irrelevant because improvement measures and metrics could not be accurately assessed and the funded actions wouldn't be recognized as being successful or not. This project is necessary for all other BRC projects, resulting in WQ benefits, to be accurately assessed as successful or not.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

This project provides data that is needed to identify how the lake has changes (for better or worse) over the time frame the data has since been collected (1960s – current). No WQ monitoring data was being collected since pre-settlement, but we can surmise rates of change, within the expanse of the data collection period, and how events, management actions, or climate shifts have impacted changes in WQ. This dataset is also important to monitor baseline changes over time, for example pH has been slowly increasing in Clear Lake since 1979.

For example, if we wanted to see how productivity in the lake has or is changing, and wanted to gain insights as to why, we can look at time series of variables of interest, such as total suspended solids (TSS), total phosphorus (TP), and green algae metrics (measured by Chl-a). This information is really useful if we are trying to compare information to comply with regulatory orders (Ex. TMDL with Chl-a concentration limits set to 73 ug/L) or impacts of watershed scale changes, such as a large fire occurring in the watershed, like the Mendocino Complex. Both of these scenarios are captured, with long term data below in Figure 1. These scenarios will not be possible to visualize and contextualize without continued long-term in lake monthly monitoring.

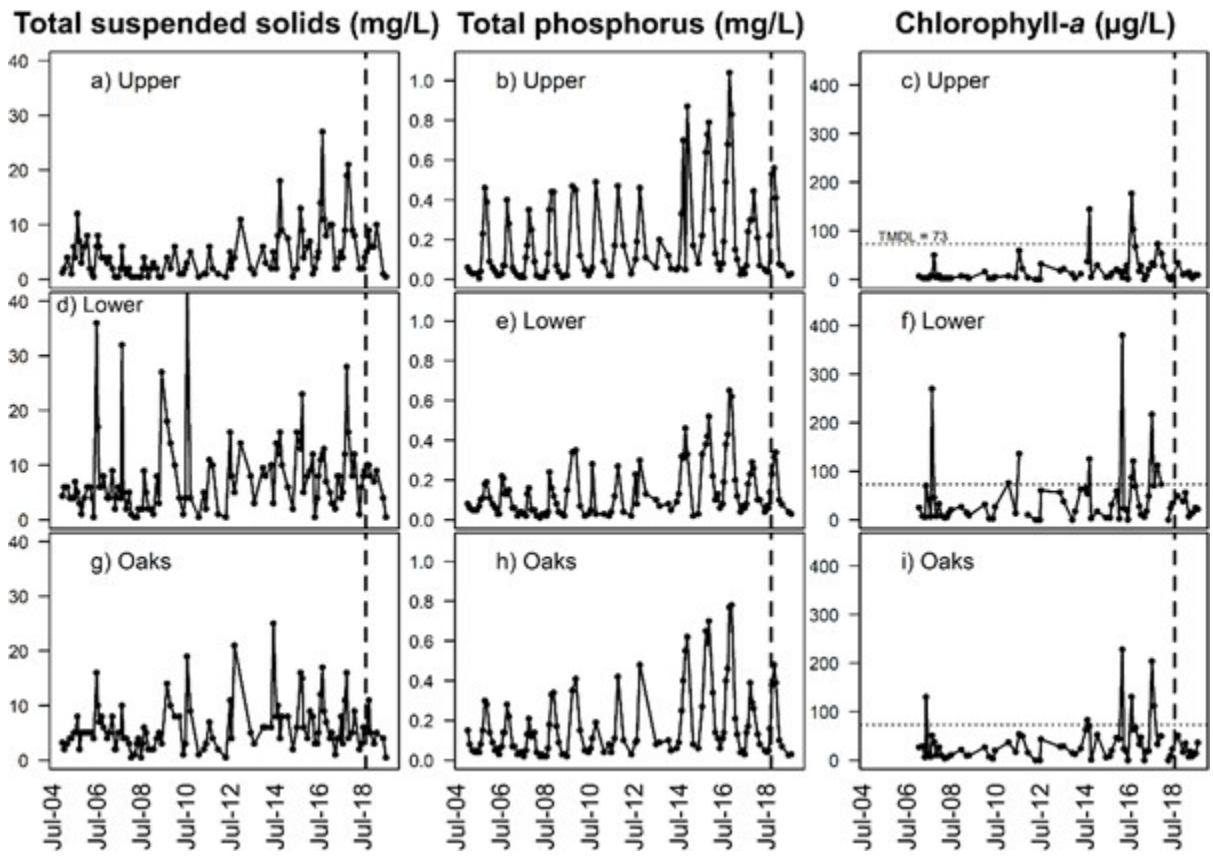


Figure 1. *Clear Lake water quality time series (monthly surface samples) for total suspended solids (left-hand column; 2004-2019), total phosphorus (center column; 2004-2019) and chlorophyll-a (right-hand column; 2007-2019) across Upper Arm (a-c; top row), Lower Arm (d-f; center row) and Oaks Arm (g-i; bottom row) of Clear Lake before and after the Mendocino Complex Fire (ignited on July 27, 2018; indicated by the vertical dashed line).*

3. How does the project demonstrate progress towards achieving the Committee's vision?

The project will provide data that answers the basic question; "what is the water quality condition" of Clear Lake, and "how do the conditions now compare to conditions before, or over time?". The answer to these questions is the crux of the BRC vision, as explicitly stated in the vision to look for sustainable solutions for rehabilitation and local management, and this project will directly provide valuable data to better understand the Clear Lake environment as it interrelates with communities, cultures, and the economy.

This project explicitly aligns with the BRC DRAFT committee goals by allowing managers, researchers, policy-makers, and the BRC to understand water quality improvements and ecological health of Clear Lake, by providing the raw data needed to assess change.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

This project does not require concept development, and this project already incorporated collaboration with a shoreline trust Lake County tribe (Big Valley) and is willing to work with other tribes (and other organizations) to maximize efforts.

We will be relying on the BRC facilitator and chair to assist in our efforts to fully incorporate tribal co-management and involvement into the project.

5. How will the fully implemented project be maintained in the long-term with the local community?

This is a really important question. The California DWR maintained this program for 52 years until terminating the program suddenly in 2020, without any continued support. The County took over the program, in an abbreviated format, and will continue as funds allow, however, current revenues generated from the Lakebed Management lease program are limited and cannot support a $100,000 program a year, let alone support the staff and data management needs of this program.

We would like to work with the BRC, and all contributing partners and members, to identify sustainable solutions to maintain this program, so that this vital data can be continued. WRD is exploring other options (revisiting ballot and voter measures, inquiries about general fund contributions, including data management and WQ monitoring support into other grant programs, etc.). Long-term funding options are currently being developed, but in the meantime, this bridge-year funding is necessary to fill a current gap of data used by all water managers of CL.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.

Water quality improvements are vital to sustaining a vibrant Lake County economy, as water quality influences drinking water rates (Lake County is currently highest in the state) and the income generated by a water-based tourism economy. Therefore, any information that can inform, shape, drive, and influence management actions that will improve water quality, is indirectly impacting the Lake County economy.

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.

This project is already developed, but we have made grand efforts to conduct outreach and community engagement, and to make the generated data publically accessible:

a. uploading data into Water Quality Databases, at both the State (CEDEN) and Federal (WQX) Portals.

b. Providing information about this project, and links to the portals, at our website here: https://www.lakecountyca.gov/1504/Clear-Lake-Water-Quality

c. Creating Learning Videos for the public to learn about the basics of Lake Sampling. Most of these videos are available on facebook, but as a government page these videos can be accessed without a facebook account, so they are freely available.

February 2021 WQ Sampling using a Van Dorn Sampler for Discrete Sampling
https://www.lakecountyca.gov/1504/Clear-Lake-Water-Quality

April 2019 History and Methods of Secchi Disk Depth for Measuring Water Clarity
https://www.facebook.com/lakecountywater/videos/322199085159030/?__tn__=%2CO-R

March 2019 Lake Sediment Sampling with WRD!
https://www.facebook.com/lakecountywater/videos/322199085159030/?__tn__=%2CO-R

We also utilize the videos to share work being conducted by our partners at UCD with BRC funds! This link is Samantha Sharp talking about spectral profiles of the lake to improve satellite projects.

https://www.facebook.com/lakecountywater/videos/269439195019853/?__tn__=%2CO-R

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.

No permitting is needed for this project, however the first iteration of the project was filed under CEQA as CatX and this continuation project can easily follow suit.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

   The answer to this question was already explained in the initial proposal. To add to that response, monthly WQ data collected will support other research projects by providing a baseline of continuous and consistent data that is not often provided by research efforts, which tend to be patchworks of data collections in space and time, and not usually housed in one, single, publically accessible data portal / location.

Continuation of monthly ambient monitoring of Clear Lake in all three arms as part of the Clear Lake Ambient Monitoring Program (CLAMP). Since 1968, the California Department of Water Resources (DWR) has conducted ambient water quality monitoring and sampling of Clear Lake in 3 locations: the Upper, Lower and Oaks arms of the lake. Data derived from this sampling allows the State, County, Tribes, and other impacted local organizations to identify and track key nutrients and potential contaminants. This publicly available water quality information is essential for making water quality management decisions for Clear Lake and dependent downstream areas, including the Cache Creek Watershed and ultimately, the California Delta.

Due to funding shortages in 2020, DWR terminated their monthly ambient water quality monitoring program in Clear Lake. County of Lake Water Resources Department (i.e. Watershed Protection District, herein "Lake County")) has continued an abbreviated monitoring program in the lake, although this is a burden on a department located in a disadvantaged community that does not receive general funds.

A relatively small investment in a consistent water quality monitoring program has significant management and research implications. Without some assistance, the valuable information collected from this program, which is vital to the success of any actions produced by the Blue Ribbon Committee, will be lost and impossible to attain. This loss will likely impact not just Lake County water quality management efforts, but also the 17 Public Water

Systems and an unknown number of small and private drinking water supply operations around Clear Lake, downstream water users, and the environment.

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

The answer to this question has already been answered within the packet or the original proposal.

11. Describe the proposing entity's experience on similar projects.

The contact and lead for this project is currently managing ~$6 million in grants, some implementation and some planning, including a current BRC grant for $100,000 to conduct current Limnological sampling in Clear Lake. In total, the lead of this project has been awarded $1.5 million from the BRC, and currently expending $900,000 of those awards. The proposing entity is more than able and capable of executing this project.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

This plan is not required under and existing statutory or regulatory responsibility.

Clear Lake Blue Ribbon Committee

County of Lake Watershed Protection District: Enhancing Implementation of a Natural Shoreline Stewards Program in Clear Lake, CA

January 14, 2023

Project Title: Enhancing Implementation of a Natural Shoreline Stewards Program in Clear Lake, CA

Agency: Lake County Watershed Protection District

Project Description:

This project will continue an established Natural Shoreline Stewards Program on the shores of Clear Lake, CA. In 2022, Lake County Watershed Protection District was awarded a Department of Pesticide Regulation grant to establish a Natural Shoreline Stewards program paired with and shoreline property owner incentive program. Both projects aim to convert high-impact private and commercial shoreline property into natural shorelines through incentive and educational-based solutions.

The proposed project to the Blue Ribbon Committee will continue and enhance this project by continuing project coordination by experienced district staff (Task 1.0), build upon the education of staff and partners in hiring and training (Task 2.0), Continue and expand the Natural shoreline Incentive Program, whereas invasive species such as creeping primrose are removed and restored with native plants such as tules (Task 3.0) and continue the community Outreach and Education Program (Task 4.0). In addition, this project will include the creation of several public land natural shoreline projects as demonstrations for the community (Task 5.0 – 7.0).

The proposed project will plan for and permit at least two public shorelines (Task 5.0), create and install at least two natural shorelines on public properties (task 6.0), and maintain these shorelines for the duration of the grant period (task 7.0) which includes the control and removal of invasive primrose and management of native plant species such as Tules (*Schonoplectus acutus*), aquatic smart weed (*Polygonium aquaticum*), spikesedge (*Eleocharis spp.*), water plantain (Alisma spp.), alders (Alnus spp.) and other native and beneficial wetland species like willows (Salix spp.), sedges (Carex spp.) and others.

The majority of this project will revolve around the education/outreach and incentive program for individual and commercial shoreline property owners (Task 3.0, and Task 4.0). Task 3 will provide incentives for private/commercial property owners to take advantage of Integrated Pest Management (IPM) methods, in additional to traditional methods, among parcels around the shorelines of Clear Lake. However, current local capacity limits the success of this task at around a maximum total acre a year of shoreline area. Therefore, this proposed project also includes a local capacity building task (2.0) that will not only train and certify local agency and organizational staff, but recruit local contractors to become skilled and certified in Natural Shoreline restoration techniques. This task mimics those conducted by other well-known and successful programs such as Michigan's Natural Shoreline Partnership and Vermont's Natural Shoreline Erosion Control Certification Program.

Task 3.0 will not be limited in geographic scope and can be implemented to any interested property owner. Success will be when interest and participation in the program meets or exceeds available grant funds. Success will also be measured through the total accumulated area of shoreline that is maintained as natural and/or converted from invasive plants, or built hardscape, to natural shoreline. At each qualifying and participating site, the District, and project partners, will conduct photo monitoring pre and post project, and provide maintenance support as grant funds allow.

In addition to incentives, Task 4.0 will provide educational and training opportunities for individuals to improve shorelines on their own. Educational units will include reducing invasive plant and animal species and encouraging natural shoreline infrastructure –both built and natural- to encourage more wildlife use, and improve water quality while reducing shoreline erosion and degradation. This task, the implementation of Natural Shoreline Stewards Program, will provide the public (private and commercial property owners) the educational tools needed to implement their own resilient and native shorelines, which are more equipped at preventing future invasions. This task will also include the creation, distribution, and instruction needed to improve shoreline resilience, to the communities around Clear Lake including shoreline property owners, regional schools, non-profit organization, tribes, work groups, and agencies. This task is direct implementation of an outreach and education program, from an existing plan.

The geographic scope of task 4.0 extends beyond that shoreline and has the potential to be implemented indefinitely, as part of a holistic component for all wetland and aquatic invasive plant species management, lake management, and watershed management plans. This program can be expanded across the lake and be taught in schools as part of any environmental studies units. It is also constructed and intended to be adopted by local agencies, cities, tribes, and others who are connected and rely on Clear Lake. This task will be measured by the number of educational and outreach products produced and distributed, training sessions attended, number of participants in program, and the response rate to online participation / evaluation surveys and social media ads and promotions.

The last tasks of this proposed project will be to provide a living example, case study, to accompany all the other tasks. In order for property owners to be incentivized, and for teaching to be holistic and comprehensive, a natural shoreline demonstration area would be an extremely valuable tool. Task 5.0 – 7.0 include the tasks needed to plan, permit, construct, and maintain at least two natural shoreline area locations, located on public property on shorelines of Clear Lake. These demos will not only provide property owners exemplars to model and motivate their efforts, but the demo space will be ideal locations for staff, partner, and certified contractors to get hands-on experience and skills in creating natural shorelines.

Task 5.0 will include planning and permitting subtasks, with task 6.0 including the actual demonstration garden installation and creation, and task 7.0 will include the maintenance and post-installation management. Success will be realized when at least two demonstration natural shorelines are created and used in an outreach, teaching and training capacity. Before and after photos and lessons learned will be products of these tasks.

Together the objectives and tasks of the proposed project, *Enhancing Implementation of a Natural Shoreline Stewards Program in Clear Lake, CA*, will create a sustainable program that supports and promotes community buy-in, participation, incentives, motivation, education, and local capacity building for a common goal – Improving natural shoreline communities on Clear Lake. The conversion of shorelines from natural to developed is one of the most significant contributors to poor water quality in the Lake, and this program will provide the resources needed to reverse that contribution and start and sustain the long process for recovering Clear Lake's lost wetlands and natural shoreline communities.

Project Timeline:

Task	Start	End
Task 1. Project Coordination	Fall 2024	Fall 2028
Task 2. Hiring and Training	Spring – Summer 2025	Spring 2028
Task 3. Resident Incentive Program (Continuation of existing program) Invasive species removal & Tule planting	Fall 2024	Fall 2028
Task 4. Outreach and Education Program (Continuation of existing program)	Fall 2024	Fall 2028
Task 5. Demonstration Natural Shorelines Permitting & Planning	Spring 2025	Winter 2026
Task 6. Demonstration Shorelines Installation	Winter 2026	Spring 2027
Task 7. Natural Shorelines Maintenance (Continuation - primrose removal and management)	Spring 2025	Fall 2028

Projected Budget:

Provide overall budget request and breakdown by task (as needed). Example:

Overall budget request: $755,091
County Contribution: $147,040
Total project Budget: $902,131

Task	Grant Request	County Contribution
Task 1. Project Coordination	$ 82,591	$ 41,290
Task 2. Hiring and Training	$ 77,000	$ 21,000
Task 3. Resident Incentive Program (Continuation of existing program) Invasive species removal & Tule planting	$ 150,000	$ 10,000
Task 4. Outreach and Education Program (Continuation of existing program)	$ 150,000	$ 45,000
Task 5. Demonstration Natural Shorelines Permitting & Planning	$ 18,500	$ 3,250
Task 6. Demonstration Shorelines Installation	$ 262,500	$ 22,500
Task 7. Natural Shorelines Maintenance (Continuation - primrose removal and management)	$ 14,500	$ 4,000

Project Grand Total	$902,131
Total Requested from CNRA	**$755,091**
Project Contribution / Match from Lake County	$147,040

Contact Information:

Angela De Palma-Dow, Lake County Watershed Protection District, (707) 263-2344, Angela.DePalma-Dow@lakecountyca.gov

Addendum: Enhancing Implementation of a Natural Shoreline Stewards Program in Clear Lake, CA

Addendum to Address Committee Proposal Requirements

Contact: Angela De Palma-Dow, County of Lake Water Resources Department, Angela.DePalma-Dow@lakecountyca.gov

Primary Requirements. These are critical for the Committee's consideration of each proposal:

1. Does the project contribute to improving the physical and biological health of Clear Lake? How?

Yes this project directly contributed to improvements in the physical and biological health of Clear Lake, specifically by creating strong, sustainable shoreline habitats, ecosystems, and environments. Integrated Pest Management (IPM) techniques, combined with community education and outreach, will be used to remove, manage, and prevent future spread of a destructive, invasive aquatic plant called creeping yellow water primrose (*Ludwigia peploides*, herein referred to as "primrose") while creating skilled local capacity, to maintain the program sustainably. Dense biomass of primrose can pose a serious nuisance for human activities such as impeding navigation, reduced recreational capacity, restrict fish habitat, and primrose reduces flow in channels, contributing to localized flooding (i.e. physical health of Clear Lake). Abundant primrose and infrastructure damage and can clog drinking water intakes, reducing needed water quality and quantity for treatment systems to function properly (Grewell et al. 2016). The aggressive nature of Primrose allows it to displace and disrupt native riparian and wetland plant communities of Clear Lake, including those comprised of culturally and ecologically significant tule (*Schoenoplectus acutus*), smartweed (*Polygonium amphibium*), and water spikerush (*Eloacharis palustris*) (i.e. the biological health of Clear Lake). The spread of primrose is especially concerning for public health agencies as primrose surface mats create protective habitat for mosquitos (Greenfield et al. 2004). Primrose structure inhibits the penetration of larvicides, making vector control efforts futile when managing mosquito populations, especially those transmitting West Nile virus (Sears et al. 2006). Project partners at Lake County Vector Control, have observed higher abundance of West Nile mosquito emergence during periods of abundant primrose growth and reduced emergence post herbicide and manual removal treatments.

2. Does the proposal describe baseline conditions (the current state) and goals (desired future state) it seeks to achieve? How?

In this case, baseline conditions would indicate a complete removal of primrose, or eradication, from all areas of Clear Lake. While this project aims to reduce the size of significant areas of primrose, and prevent primrose from establishing in large areas of significance, this project does not promote an eradication of primrose, as that is not a feasible goal with the scope of this project. Through this project, we will achieve other significant deliverables (i.e. Task 2 training local contractors to conduct primrose removal and native plant restoration, providing education to local shoreline property owners to maintain their own shorelines and conduct primrose management, and provide pathway for natural shoreline restoration) that will create long lasting capacities that make the goal of eventual eradication possible and even, attainable.

3. How does the project demonstrate progress towards achieving the Committee's vision?

The project will increase local capacity for invasive species control and management by utilizing the local community that is already present on the shoreline of Clear Lake. Integrating private property shoreline owners would be integral to project success because most of the CL shoreline is privately owned. Lake shoreline restoration is practically impossible without the involvement and buy-in of private property owners.

This project will also create ecological and economic lift by creating a local workforce to conduct invasive species removal and native plan restoration (keeping $$ in the local community and providing training to local businesses and individuals for a service that does not yet currently exist to meet the current needs and demands), providing resources to property owners to conduct invasive species management and native plant restoration directly, and provides education to assist in the elimination of barriers to improving water quality, and through the use of demonstration gardens, and associated outreach, both of these aspects of the project can be communicated to the public, private, commercial, and research sectors.

4. How will the seven Native American Tribes in Lake County be actively included in project design and implementation (starting with project concept development)?

Tribal representatives will be contacted to and invited to participate in the project directly, encouraged to improve outreach and educational materials, provide tribal oversight to demonstration shorelines, and participate directly in capacity building, training, and demonstrations.

We will be relying on the BRC facilitator and chair to assist in any contact outreach so that we are able to fully incorporate tribal co-management and involvement into the project.

5. How will the fully implemented project be maintained in the long-term with the local community?

Task 2 will actually enhance and expand on a local workforce, to be skilled and familiar with conducting primrose removal and native shoreline restoration, which can be hired by property owners. The skills provided in these tasks within the projects will remain long after the project is completed, as the local contractors will now be able to provide these services to the local community, which is non-existent now and therefore not affordable or attainable, however providing these skills, education, and opportunity to boost the local workforce will provide sustainable long-term impacts where there is future funding for this project or not.

For task 3-4 This project will provide educational resources and tools for individual property owners to conduct their own shoreline maintenance. This project will conduct removal and management for private properties combining invasive species removal and native plant restoration. Native plant restoration will prevent future invasive establishment – with proper maintenance, which will be part of the agreement between the homeowner and the District when providing the initial primrose removal services. Therefore, this aspect of the project is self-sustaining, as property owners, once armed with the knowledge of how to maintain their own shoreline, will help contribute to the overall lake—wide effort to manage, control, and eventually eradicate invasive primrose from Clear Lake shores.

For task 5-7 Include the construction of a Natural Shoreline Demonstration areas which will be on public property and will be maintained by the County of Lake, and partners, so that they can continue to function as a living classroom and teaching tool, as well as provide the immediate benefits to a living, natural shoreline on Clear Lake.

Secondary Requirements. To the greatest extent possible, proposals should also:

6. Describe how the project is expected to improve or impact the Lake County economy.

According to 2019 County Health Ranking Database, Lake County median income ($46,900) is approximately $33,500 less than the state's overall median income ($80,400), indicating that the locally generated resources available for community services, such as invasive species management, is extremely limited. Although further primrose expansion threatens to degrade Clear Lake, the County's number one economic driver, there is little to no local available funds to start and maintain an effective large-scale AIS program for primrose – which is an essential component for any shoreline restoration efforts.

Additionally, Clear Lake provides drinking water to 60% of Lake County's population, yet due to the poor water quality of Clear Lake (it's listed on the US EPA Impaired Water Body 303(d) list) the drinking water rates are among the 3rd highest in the state, and aquatic herbicide set-backs to intakes prevent chemical control management in several significant areas of the lake, making comprehensive invasive plant management difficult. The communities surrounding the Lake are majorly disadvantaged, severely disadvantaged, and tribal communities, making any community-sustained AIS / IPM efforts unlikely due to cost and lack of financial stability. Lake County has also suffered from multiple federal and state-declared wildfires (n=7) and floods (n=2) since 2014 alone. Therefore, Lake County being highly impoverished, paying high drinking water rates, still in recovery from destructive natural disasters, yet highly dependent on a healthy and vibrant Clear Lake to support the economy, can only benefit from this project.

This project will provide educational resources and tools, in combination with incentives, for individual property owners to conduct their own natural shoreline maintenance. This aspect of the project is self-sustaining, as property owners, once armed with the knowledge of how to maintain their own shoreline, will help contribute to the overall lake—wide effort to manage, control, and eventually eradicate invasive primrose from Clear Lake shores.

7. Describe the outreach/community engagement necessary to build understanding of and support for the project. This may include (but is not limited to) a description of who will be engaged, and which existing groups will collaborate to increase project awareness/community buy-in.

This project is based on the existing project that was awarded under a DPR Alliance Grant to create strong, sustainable shorelines on Clear Lake. While the DPR granted project focused on public locations, and developed the tools and education needed to initiate a Natural Shoreline Stewards program, this project proposes to extend and enhance that previous effort. However, the outreach and community engagement efforts of the previous DPR grant project and Alliance Team structure will remain.

While additional partners and collaborators are welcome, we will include the following contributors (i.e. The Alliance Team) into the currently proposed project.

The collaboration of this unique Alliance Team, comprised of local, state, tribal, and NGO entities, can serve as a model for other programs throughout California. The Alliance Team will be essential in distributing the message of this important project and providing valuable consult as the project progresses. The Alliance Team members will be provided opportunities to participate in every aspect of the project, to ensure success in reaching the projects goals and objectives. We will employ an open and transparent communication strategy, with regularly scheduled virtual update meetings and coordinated field visits. Work days to create demonstration shorelines, participate in private and public primrose removal and Native Tule & Plant Restoration will be open to Alliance Team members, and their staff, with several of the team members having already contributed to similar pilot project activities in the past and committed to the duration of this proposed project. The District has even included some Alliance Team member support within the proposed grant budget (task 2) so that members, or their staff, have opportunities to participate directly in the project.

(*Below is previous identified partners and supporters on first DPR-funded phase of project, ***indicates received communication for continued support for this project, with intent to submit formal letter for May BRC meeting***)
*Tribal EcoRestoration Alliance (TERA) is a non-profit local tribal organization that has provided restoration capacity to the District in previous years and will be a pivotal member for majority of tasks, including providing education and outreach, creating demonstration gardens, and serving as a resource for primrose removal and tule restoration on private and public properties.
*Bull Frog Underwater Services (Franklin Lee) will provide manual removal services for our incentive program and provide training and guidance for capacity building.
*Clear Lake Keys POA support the project and will participate where needed for regional sites.
*Lake County Vector Control District will provide project input, and mosquito emergence monitoring at applicable project sites, as warranted.
Lake County Resource Conservation District (RCD) will provide matched expertise and consult on project for all tasks.
*Lake County Department of Agriculture will provide consult where needed as coordinators of the Lake County Weed Management Area (WMA) and for permit requirements.
*Lake County Land Trust (LCLT) has recently acquired Clear Lake –adjacent wetland restoration areas in South Lakeport that can serve as prime locations for natural shoreline restoration and demonstration shoreline areas, and areas to conduct trainings.
Big Valley Band of Pomo Indians (i.e. Big Valley), Robinson Rancheria, and Habematolel Pomo of Upper Lake will be essential in all restoration and education efforts, as they have either been conducting manual primrose removal and native replanting on their shorelines, conducting other natural shoreline management, or providing education and outreach to communities. Tribes will be essential on providing consult and expertise on removal and site planning for training purposes, will also assist in the promotion of the incentive program and Natural Shoreline demonstration maintenance and management (ecological burn).
*Redbud Audubon Society will provide support for outreach and education.
California Department of Food and Agriculture (CDFA) Hydrilla Program is a strong supporter of this project and can provide field support as needed and monitoring assistance, as the success

of this project will enable success of their efforts in reducing pesticide treatments needed to mitigate invasive hydrilla in Clear Lake.

8. Identify all local, state, and federal permitting requirements (including environmental review through NEPA/CEQA) required for project implementation. Describe a process for coordinating with appropriate local, state, and federal agencies.

Tasks 1 – 4.0 of this project do not require any permitting as all activities are currently covered under the current Clear Lake Integrated Aquatic Plant Management Program and current Stream Bed Alteration Agreement (held by County of Lake Water Resources) that allows invasive species management (up to 5 acres annually). We expect to file CEQA CatX for restoration projects on public lands and smaller, individual efforts in private parcels won't qualify for CEQA under the size-trigger threshold.

Task 5-7 will file for CEQA, under exemption, as demonstration projects, while they disturb the ground, are being assembled for educational and training purposes and are still qualified as restoration projects and therefore do not pose a significant impact.

9. Describe how the proposal uses existing research in its design and outline how the work leverages/builds on past and current research outcomes.

Preliminary information gathered to inform this project was produced under the Score the Shore project, which inventoried the entire shoreline of Clear Lake between 2020-2022. This project identified areas where shoreline development has eliminated natural shorelines, and what areas could most benefit natural shoreline stewardship. Using the information in the score the shore, we can better plan shoreline projects and prioritize resources and efforts to educate property owners and implement restoration activities. WRD also completed a visual survey of the entire shoreline and is currently analyzing high-resolution aerial imagery.

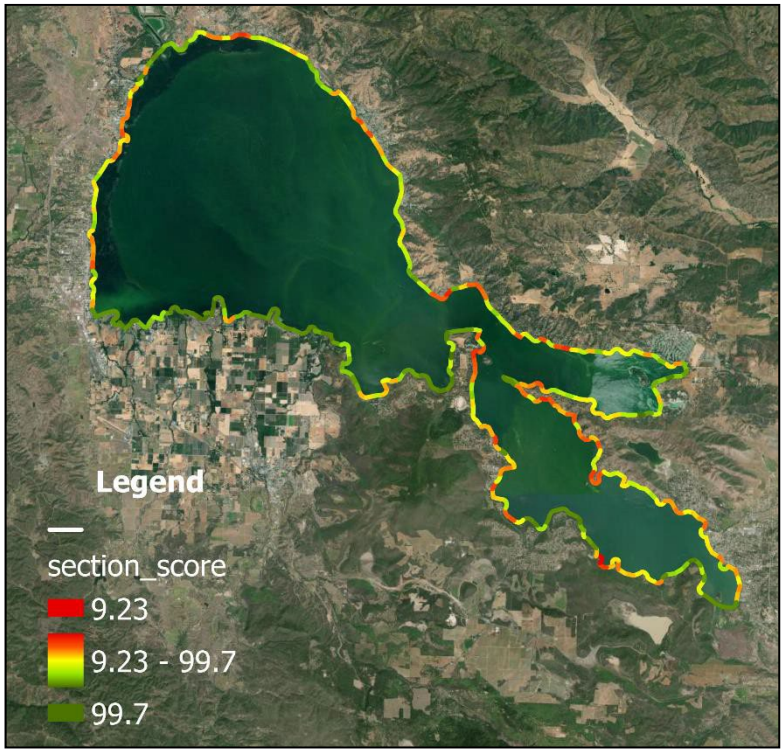


Figure 1. "Score the shore" shoreline inventory completed in 2020-2022. Inventory along the shoreline is based on assigning scores to hardscapes, structures, slopes, erosion, down woody debris and natural shoreline plant communities. Poor health shoreline scores are reflected in red (lower value) and healthy shoreline scores are reflected in green (higher value).

This project is also a continuation of an existing project that was awarded under a DPR Alliance Grant to create strong, sustainable shorelines on Clear Lake. While the DPR granted project focused on public locations, and developed the tools and education needed to initiate a Natural Shoreline Stewards program, this project proposes to extend and enhance that previous effort.

This project will also build off of previously existing natural shoreline steward programs such as those exemplified by the Delaware Living Shoreline Committee, North Carolina Living Shores Academy, The Pacific Northwest Green Shores Program, Michigan Natural Shoreline Partnership, Minnesota's Restore Your Shore. We have notes on all of these programs thanks to a 2022 partnership with AmeriCorps, and those can be available upon request by the Committee or any Committee members.

However, a strong component of our project is a focus on providing education and outreach around natural shorelines, especially for invasive species management. Based on our research, no studies have been conducted to identify if public education is effective against specifically *Ludwigia spp*. however, IPM education and outreach has been a shown and proven method effective for other aquatic plant species (Thiebaut 2007; Laguna de Santa Rosa Foundation 2008; Aldridge et al. 2017; Grewell et al. 2016). Thouvenot et al. 2013 strongly indicates that an intensive public education campaign is needed to avoid introduction of invasives into new environments or areas and that even localized prevention and eradication is an effective invasive management strategy.

10. Use existing data to the maximum extent feasible *OR* describe specific data gaps expected to be filled through project implementation.

We currently do not have any data regarding natural shoreline restoration on Clear Lake, except what has already been developed and implemented by BRC committee projects or members. This project, in addition to information gathered from our previous investigation "Score the shore" would help to inform target areas for shoreline restoration and education and outreach. We will also rely on community input, and partner and collaborators input, when targeting efforts around the lake.

However, part of this project (i.e. contractor training for natural shoreline engineering, developing curricula) would somewhat rely on expertise and knowledge of natural shoreline specialists from other states to help guide some aspects of the project.

11. Describe the proposing entity's experience on similar projects.

The contact and lead for this project is currently managing ~$6 million in grants, some implementation and some planning, including a current DPR Alliance Grant for $350,000 for primrose management and natural shoreline restoration and stewardship. Additionally, the lead of this project has been awarded $1.5 million from the BRC, and currently expending $900,000 of that. The proposing entity is more than able and capable of executing this project.

12. Informational only: Describe whether the project seeks to address an issue under existing statutory or regulatory responsibilities of the entity leading the effort, and why the issue has not been resolved previously (i.e., lack of alternative funding sources, staff resources, local expertise, etc.).

This plan is not required under and existing statutory or regulatory responsibility.

Clear Lake Blue Ribbon Committee

County of Lake: Dredging Boating Ways and Stream Mouths of Clear Lake

5.3.2023

Project Title: Dredging Boating Ways and Stream Mouths of Clear Lake

Project Description: The County of Lake (County) seeks to acquire funds to design and perform multiple dredging projects around the public access areas of Clear Lake. The goals of these dredging projects are multi-benefit; to increase the navigable depth, reduce nutrient sediment bars / bioturbation potential, and improve fish passage at various stream mouths around Clear Lake.

The County will create and distribute an RFP, then complete contracting with a qualified and experienced engineering consultant and/or company. The contractors will prepare bathymetric surveys, water and material testing requirements, dredge calculations, project design, improvement plans, permit applications, perform engineering assistance during construction, and preparation of improvement plans and specifications to be used as the basis for solicitation of construction bids. A contractor approved to dredge waterways will then be on-boarded to complete implementation of the project and disposal of material.

Benefits:

- Removing sediment nutrients from Clear Lake (high phosphorus loaded sediments fuel HABs and contribute to internal loading)
- Improve fish passage for creeks by removing barriers at tributary mouths
- Improve recreational and emergency access to the Lake by removing sediment, allowing parks jurisdiction to apply for ramp extension grants and implement those projects

Potential Proposed Areas:

- Rodman Slough / Kelsey Creek
- 3rd / 5th St Ramp
- County Park Ramp
- Keeling Park Ramp
- Clearlake Oaks Ramp
- Redbud Ramp
- Cole Creek (Clear Lake State Park)
- (potential for other stream mouths)

*Target dredge depth of -4.5ft Rumsey for the boat ramps (selected areas dependent on bathymetric survey results and project management guidance)

Project Components:

There are two main project components, each with associated subcomponents. Firstly, project management which sets up the project, obtains required permits, reports, studies, and helps with the development of an RFQ to solicit qualified contractors that will be conducting the actual dredging work. Secondly, the dredging implementation portion includes selected contractor will remove sediment and dredge at selected sites to established depths and dispose of recovered material appropriately.

- Project Manager (includes permitting, required technical studies, cultural reports, sedimentation plan, archeological report, bathymetric surveys) ~40% of project costs

- Dredging Implementation (includes material removal and disposal) 60% of project costs

Additional Projects/Benefits:

Dredged boating lanes will allow the County and Cities to apply for grant funding to extend boat ramps through the California Division of Boating and Waterways. Currently, many boat ramp extensions are not possible due to higher lakebed elevations just outside the ramp drop offs where material has deposited from boating, runoff, and wave action.

Dredging and extending boat ramps have additional multi-benefits to recreation including reduced bioturbation in the littoral zone. This is due to the reduced turbidity props cause over a cement boat ramp compared to the natural lake bottom.

Quantifying Project Success:

There are many ways to quantify success of this project, including tangible improved navigable depths, estimated nitrogen / phosphorous removed from Clear Lake, and visible accounts of improved hitch spawning runs.

The Lucerne dredging project for example will remove an estimated ~2 tons of phosphorous and ~0.4 ton of Nitrogen by dredging 2500 cu yards of sediment. The annual load limit established by the Water Resources Control Board for Clear Lake regarding phosphorous is 95 tons, which means the Lucerne Dredging Project alone is removing ~2% of the annual load limit of phosphorous for Clear Lake. Nutrients removed by dredging other areas can be quantified in a similar way as above.

Below is a table illustrating the load contributions from major tributaries into Clear Lake.

Table 3. Phosphorus load allocations for non-point sources.

Watershed Group	Existing TP Loading (kg/day)	% TP Loading to Clear Lake	TMDL Loading (kg/day)	Percent Reduction
Intermediates	126.04	23%	81.93	35%
Schindler	26.79	5%	21.43	20%
Scotts/Middle	169.55	30%	67.82	60%
Adobe	30.06	5%	22.55	25%
Cole	23.20	4%	18.56	20%
Kelsey	35.74	6&	26.80	25%
Total	411.39		239.10	

*Courtesy of Clear Lake Watershed Sanitary Survey Update 2017

Potential Project Partners:
The Clear Lake State park would like to partner, specifically related to dredging their channel (Cole Creek) to improve boat and fish passage. It is the intent that they be included as a project partner for that specific channel. They are interested in potentially leveraging some of their resources to partner on the project.

CDFW has been briefly introduced to the concept project and Fisheries Biologist, Ben Ewing responded saying: "*I believe when done correctly, that dredging stream mouths can be very beneficial, especially to hitch. Kelsey Creek, Schindler Creek, and Rodman Slough are all spots that I believe could use some help."- Ben Ewing.* It is the intention to collaborate with CDFW, not only from a permitting standpoint, but from a technical standpoint to ensure conservation benefits. Grant funding from CDFW will continue to be explored to enhance and expand the project.

The tribes around Clear Lake will also be integral to the project's success since a lot of earth will be moved and there is the potential to unearth cultural artifacts. Further, it would greatly enhance the project to incorporate tribal ecological knowledge into the project in relation to fish passage up various Clear Lake tributaries.

Project Timeline:

- **Year 1:** Planning and permitting, CEQA, outreach, Project Manager Onboarding.
- **Year 2:** Finishing permitting / required reports and soliciting an RFQ for dredging
- **Year 3:** Dredging contractor onboarding and implementation of dredging at various locations

Projected Budget:

- Overall budget request: $2,500,000
    - Task 1: Project Management: $200,000

- Task 2: Permitting and CEQA: $135,000
- Task 3: Studies and Reporting: $90,000
- Task 4: Surveying and Monitoring: $50,000
- Task 5: Outreach Meetings / Materials: $25,000
- Task 6: Dredge Implementation: $1,500,000
- Task 7: Material Disposal: $500,000

**Project scope can be reduced to address less areas if funding is limited.*

***Estimations were based on costs associated with the Lucerne Harbor Project and extrapolated for additional areas.*

Contact Information:

William Fox

Program Coordinator

Lake County Water Resources Department

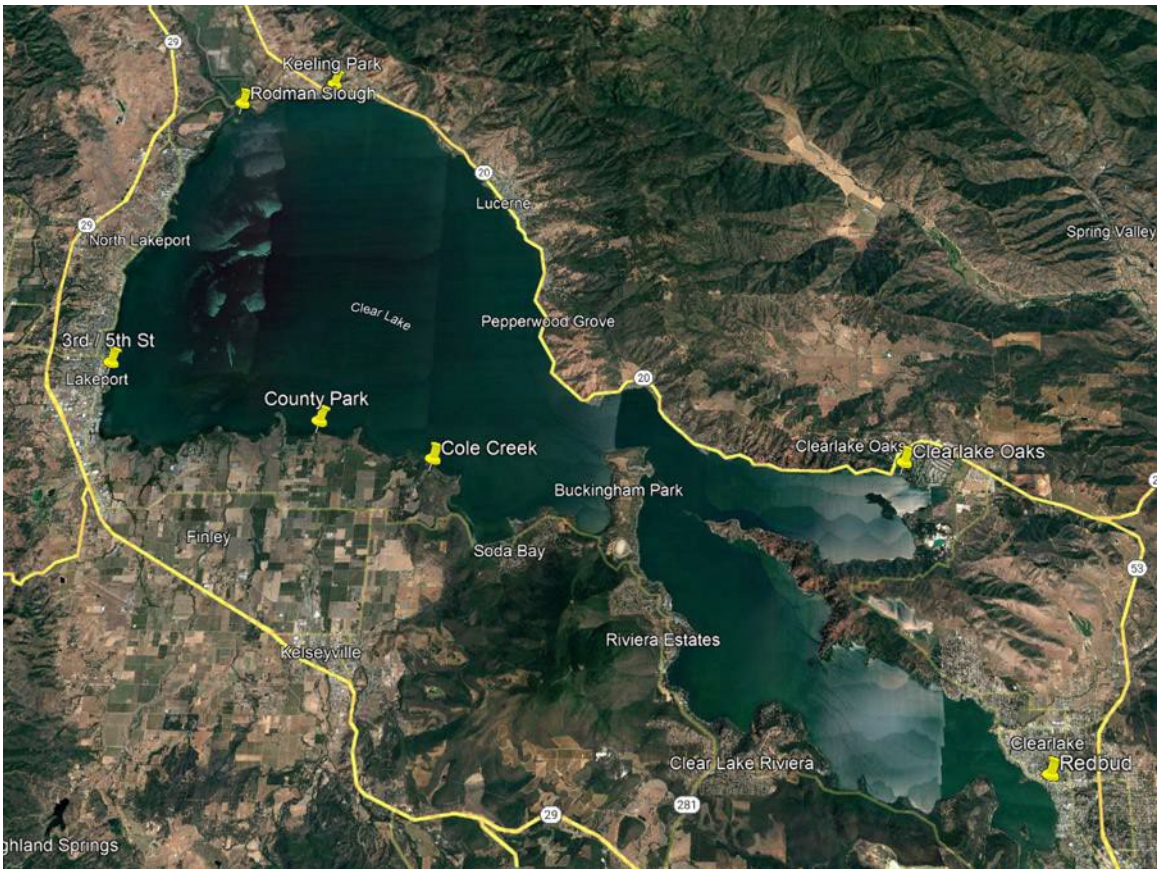
William.Fox@lakecountyca.gov

Office: 707-263-2344 Cell: 707-530-5014

Additional Information:

Rodman Slough Aerial

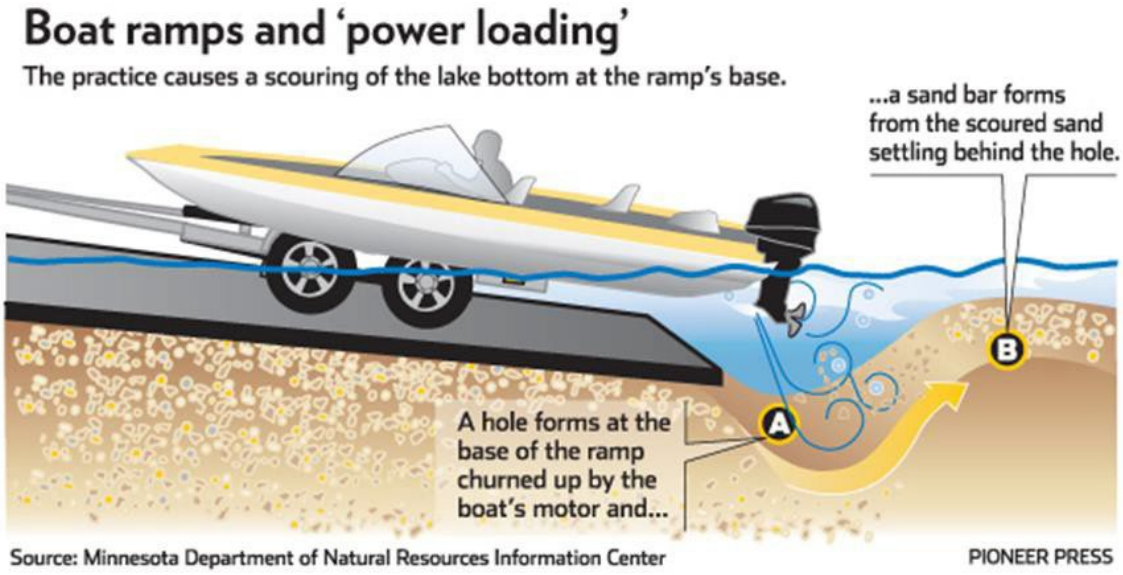
*Taken Aug 2022



*Potential Proposed Locations

*Bathymetric surveys already conducted in 2021 for 3rd St, 5th St, County Park, Clear Lake Oaks, and Redbud Ramps (too large to attach, contact via email to receive information)

<u>Power Loading Example:</u>



Required Permits Example:

Agency	**Laws/Regulations**	**Permit, Approval or Authorization**
U.S Army Corps of Engineers (USACE)	Clean Water Act (CWA) Section 404, 33 U.S.C 408, Rivers and Harbors Act Section 10	Regional General Permit
Central Valley Regional Water Quality Control Board (RWQCB)	CWA Section 401, 402, California Porter-Cologne Water Quality Control Act	Section 401 Water Quality Certification
City of Lakeport	City Code	Conditional Use Permit
City of Clearlake	City Code	Conditional Use Permit, Lakebed Encroachment Permit
County of Lake	County Code	
U.S Fish and Wildlife Service (USFW)	Endangered Species Act (ESA)	Determine ESA applicability in regards to take authorization
California Department of Fish and Wildlife (CDFW)	California Endangered Species Act (CESA) and California Fish and Game Code Section 1602 / 2081	Lake and Streambed Alteration Agreement
California Office of Planning and Research (OPR)	California Environmental Quality Act (CEQA)	File CEQA determination

State of California • Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION
400 Glen Drive, Oroville, Ca 95966

Gavin Newsom, *Governor*
Armando Quintero, *Director*

March 20, 2023

Blue Ribbon Committee for the Rehabilitation of Clear Lake
California Natural Resources Agency
715 P Street, 20th Floor
Sacramento, CA 95814

California Department of Parks and Recreation Letter of Support for Dredging of Boating Ways and Stream Mouths of Clear Lake

Dear Committee Members:

California State Parks, Northern Buttes District, supports the Lake County Watershed Protection District's proposed project to dredge boating ways and stream mouths of Clear Lake. As the managing agency of two of the largest public lands along Clear Lake's shoreline, Anderson Marsh State Historic Park and Clear Lake State Park, and as a potential beneficiary of the project, we recognize its significant positive influence on recreation, water quality, habitat restoration, and climate resilience that will help the Blue Ribbon Committee (BRC) achieve its mission.

Consistent with the vision and goals of the BRC, this multi-benefit project will address long-standing recreational boating access issues associated with the siltation of public launch ramps, remove legacy contaminants from the lake, and reestablish critical passageways for the Clear Lake Hitch, a species that is culturally significant to the many tribal communities around the lake which is also listed as a threatened species under the California Endangered Species Act.

We strongly encourage BRC's financial support of this project to realize large-scale, lake-wide benefits to the county's economy, the environment, local cultures, and adjacent communities, many of which are identified as economically disadvantaged. Please approve this project as presented by the Lake County Watershed Protection District.

Sincerely,

Matt Teague
District Superintendent
Northern Buttes District

Cc: Jared Zucker, District Services Manager