CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

RESOLUTION NO. R6T-2010-0014

REQUEST FOR CLEANUP AND ABATEMENT ACCOUNT FUNDS TO CONTROL ASIAN CLAM INFESTATION IN LAKE TAHOE

El Dorado County

WHEREAS, the California Regional Water Quality Control Board, Lahontan Region (Lahontan Water Board), finds:

1. The primary responsibility for the protection of water quality in California rests with the State Water Resources Control Board and the nine Regional Water Quality Control Boards.

2. It is the responsibility of the Lahontan Water Board to regulate the activities and factors that affect or may affect the quality of waters of the region to achieve the highest water quality consistent with the maximum benefit to the people of the State.

3. The Water Quality Control Plan for the Lahontan Region (Basin Plan) was adopted in 1995. The Basin Plan identified the need to protect the surface and groundwaters of the Lake Tahoe Hydrologic Unit.

4. The non-native Asian clam (*Corbicula fluminea*) was detected in Lake Tahoe in 2002 and since then has expanded its infestation.

5. The Asian clam poses a threat to water quality and beneficial uses through transformation, concentration and excretion of high levels of bio-available nitrogen and phosphorus into the water column and sediment substrate. Asian clam colonies on the south east portion of Lake Tahoe contributed to nearshore blooms of filamentous algae in 2008 and 2009. These algal blooms negatively affected the aesthetic enjoyment of Lake Tahoe. Additionally, decomposition of Asian clam shells increases localized calcium concentrations in the sediment substrate, creating a more suitable habitat for potential establishment of invasive zebra and quagga mussels.

6. Lahontan Water Board staff, as a participant in the Lake Tahoe Aquatic Invasive Species Coordinating Committee and the Asian lam Working Group, supported a report, *Development of Asian Clam Control and Monitoring Plan Strategies for Lake Tahoe* (Attachment A). The report, completed in fall 2008, includes a four part management plan: I) Field

testing of removal options and identification of science needs, II) Evaluation of a recommended strategy for Asian clam control, III) Implementation of the control strategy, and IV) Long-term monitoring to evaluate success.

7. On March 9, 2009, the State Water Resources Control Board authorized an urgency request of $100,000 from Cleanup and Abatement Account funds to supplement $303,248 from other agencies to implement an Asian clam removal pilot project in Lake Tahoe. The Asian clam removal pilot project is Part I.a. of the four part management plan. California's Tahoe Resource Conservation District administers the pilot project.

8. On June 2, 2009, the State Water Resources Control Board authorized an additional $100,000 in Cleanup and Abatement Account funds to implement an Asian clam survey of Lake Tahoe. The lakewide survey used an autonomous underwater vehicle to determine the extent of the Asian clam infestation, including deepwater surveys where SCUBA divers cannot travel. The UC Davis Tahoe Environmental Research Center administers the project in collaboration with researchers from the University of British Columbia. The Nevada Division of State Lands authorized $20,000 to fund collaboration with researchers from the University of Nevada Reno to implement the survey project. The lakewide survey for Asian clam infestation is Part I.b.i. of the four part management plan. Data from the survey effort is undergoing review, but initial reports indicate that previously unknown populations of Asian clams were found, including the presence of clams at depths of 70 meters.

9. The pilot clam removal project and the lakewide Asian clam survey are both included in Part I of the Asian clam management plan. Findings from the pilot project and survey are necessary to conduct Part II of the clam management plan. The final report on the initial pilot project is anticipated in late March 2010. The completion of the survey report is anticipated July 2010, with preliminary data assembled in March 2010. Actions taken in Part III and Part IV of this plan are contingent on results and findings from Part I.

10. In the 2010 field season the UC Davis Tahoe Environmental Research Center, in collaboration with University of Nevada Reno, and the Lake Tahoe Asian Clam Working Group, is implementing an expanded pilot Asian clam control project in the southeast shore of Lake Tahoe. The 2009 small scale pilot project determined that rubber bottom barriers are effective at reducing dissolved oxygen concentrations causing Asian clam mortality over a month long treatment period at peak lake water temperatures (18 to 20°C). The purpose of this installation in 2010 is to

understand the logistics, cost effectiveness, and impact to Asian clam and other benthic macroinvertebrates, as well as recolonization rates of these species on a larger spatial and temporal scale. For the 2010 project, a one-half acre project site is in California and a one-half acre site is in Nevada. The two sites were chosen because of their significant differences in substrate and clam population density. The 2010 project is being funded by $243,000 from Southern Nevada Public Lands Management Act (SNPLMA) funds administered by the US Fish and Wildlife Service and $150,000 from the Nevada Division of State Lands.

11. The Lahontan Water Board requests that State Board authorize $27,426 from the Cleanup and Abatement Account to implement an Emerald Bay specific Asian clam survey in fall 2010 (Attachment B). The Lahontan Water Board requests that State Board also authorize $561,294 in CAA funds to support an expanded pilot project in Emerald Bay in the 2011 field season (Attachments C, D). The total request for CAA funds in this resolution will support these two projects in the combined amount of $588,720. Project costs do not include funding for environmental analysis under the California Environmental Quality Act. The Lahontan Water Board does not anticipate further requests for Asian clam funding during the following three years. The project will be administered by the Tahoe Resource Conservation District. Budget tracking and compliance monitoring will be administered by the Tahoe Regional Planning Agency.

12. The 2010 Emerald Bay Asian Clam Survey (Attachment B) will determine the extent of the Asian clam infestation in Emerald Bay and define, if any, the change in previously delineated Asian clam areas in the bay. This survey is intended as a continuance of the monitoring of the Asian clam population in Emerald Bay with the intent to implement Asian clam population control strategies (such as the installation of bottom barriers) in the 2011 field season.

13. The 2011 Emerald Bay Expanded Pilot Project is to further understand the 2010 pilot project factors, but also to experiment with additional logistical obstacles that are unique to Emerald Bay such as sloped and cobbled lake bottom, and the unusually high levels of recreational boater traffic that travel through the known Asian clam population areas. Emerald Bay is a unique habitat that will provide distinct challenges to this potential control strategy application. Lessons learned from the 2010 field season will be applied to overcome these challenges. The high cost of this proposed project is associated with challenges related to the project site.

14. Requested funds are in addition to previous money spent on Part I of the Asian clam management plan. Previous funding for Part I is detailed in Table 1:

Table 1. Funding contributed for previous projects in accordance with the Asian clam management plan.

	Pilot Eradication	Lakewide Survey	Expanded Pilot, 2010	Total
State Board CAA	$100,000	$100,000		$200,000
US FWS	$145,495		$243,000	$388,495
US Bureau of Reclamation	$8,000			$8,000
Nevada State Lands	$150,000	$20,000	$150,000	$320,000
Total	$403,495	$120,000	$393,000	$916,495

In addition, the Asian Clam Working Group members have submitted requests for further SNPLMA funds to aid Parts II and III of the Asian clam management plan. Review of these requests is not complete. The SNPLMA requests are detailed in Table 2.

Table 2. Outstanding federal requests for Asian clam projects.

Source	Requested	Purpose	Estimated project date
SNPLMA Round 10 Science	$249,887*	Deep Water (80m) Clam Ecology; Expanded scale pilot project monitoring; Economic efficiency analysis of rubber barrier technique	Field Season 2010
SNPLMA Round 10 Science	$99,395*	Potential for pathogen growth and phosphorus release under clam removal barriers	Summer 2010
Total Outstanding federal Requests	$349,282		
*Pending approval			

15. Under Water Code section 13442, upon application by a public agency, such as the Lahontan Water Board, with authority to clean up a waste or abate the effects thereof, the State Water Resources Control Board may order moneys to be paid from the account of the public agency to assist it in cleaning up the waste or abating its effects on waters of the state.

16. The Lahontan Water Board considered all comments received at its regular meeting held on April 14, 2010, in South Lake Tahoe, California.

THEREFORE BE IT RESOLVED:

The Lahontan Water Board requests the State Water Resources Control Board allocate funds from the Cleanup and Abatement Account to the Lahontan Water Board in the amount of $588,720. These funds will be used to implement Asian clam eradication actions in Emerald Bay, including an updated detailed survey, as described in this resolution.

I, Harold J. Singer, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a Resolution adopted by the California Regional Water Quality Control Board, Lahontan Region, on April 14, 2010.

Harold J. Singer

HAROLD J. SINGER
EXECUTIVE OFFICER

Attachments:

A. *Development of Asian Clam Control and Monitoring Plan Strategies for Lake Tahoe*
B. 2010 Emerald Bay Asian Clam Survey, Project Description
C. 2011 Emerald Bay Expanded Pilot Project, Project Description
D. 2011 Emerald Bay Expanded Pilot Project, Budget

Attachment A

DEVELOPMENT OF ASIAN CLAM CONTROL AND MONITORING PLAN STRATEGIES FOR LAKE TAHOE

Report submitted to

Tahoe Regional Planning Agency

and the

Lake Tahoe Aquatic Invasive Species Working Group

from

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[1]University of California- Davis

[2]University of Nevada- Reno

[3]US Fish and Wildlife Service

[4]Tahoe Regional Planning Agency

[5]Tahoe Resource Conservation District

[6]Lahontan Regional Water Quality Control Board

[7]Nevada Department of Wildlife

[8]Nevada Division of State Lands

[9]California State Lands Commission

[10]California State Parks

A. INTRODUCTION

Asian clam (*Corbicula fluminea*) is a non-native freshwater bivalve that has established in Lake Tahoe and is causing apparent associated environmental impacts. It has been observed in Lake Tahoe at very low densities since 2002, but recently (April 2008) populations have been discovered in much higher (50-3000 clams m^{-2}) but patchy densities in the southern (CA-NV) portion of the lake. Members from Universities of California- Davis and Nevada- Reno (UCD and UNR respectively) conducted exploratory research since the discovery of the increased Asian clam populations in April 2008. University researchers and agency staff from the Tahoe Regional Planning Agency (TRPA), Tahoe Resource Conservation District TRCD, U.S. Fish and Wildlife Service (USFWS) and the Lahontan Regional Water Quality Control Board (LRWQCB) recently formed a working group to prioritize research, monitoring, and control projects of Asian clam populations in Lake Tahoe. The objective of this document is to provide **the full suite of research needs as called for by a complete science plan** with regard to Asian clam management. In this context, research includes scientific information related to Asian clams as well as information related to the logistics of the *in situ* field removal operations. The amount of funding available will determine the prioritization of the proposed research below. To date, we have $100,000 committed from U.S. Fish and Wildlife Service, $100,000 from the emergency clean up and abatement funds from Lahontan Regional Water Quality Control Board, and $125,000 from the Nevada Division of State Lands. This sum allows us to immediately begin project work as enumerated below in Part 1a only—which includes pilot testing and research of removal and abatement techniques. This work is scheduled to begin in February 2009. Additional funds are needed to complete remaining tasks in 2009, and also into 2010.

B. Problem Statement

Asian clam are known aggressive invaders that have significant environmental impacts. Through Lake Tahoe field surveys, laboratory experiments, and literature reviews conducted since April 2008, UCD and UNR researchers have found that Asian clam 1) excretes elevated levels of nitrogen and phosphorus into the water column and sediment substrate 2) filters high volumes of water, and 3) have a strong correlation to the growth of large, nuisance blooms of bottom-dwelling, filamentous algae in the shorezone. Potential impacts of exponential increases of this species include degraded water quality, decline of pelagic phytoplankton and zooplankton communities, disruption to Lake Tahoe sports fisheries, increased levels of calcium through the concentration of dead shell matter with a promotion of other regional exotic species (Quagga), and out-competing Tahoe's native benthic species such as the Montane Pea clam (*Pisidium* spp.) and the Ramshorn snail (Planorbidae). Given these potential impacts, there is increasing recognition to develop an effective control strategy of Asian clam populations, predicting their spread, as well as the prevention of future invasive species (e.g. quagga and zebra mussel, the spiny water flea, etc.) introduction and establishment.

It is important to note that there is no obvious, simple option that has been proven to control Asian clam at other locations, therefore, eradication of Asian clam in Lake Tahoe is unlikely. However, management aimed at minimizing Asian clam population growth and impact to Lake Tahoe may be feasible. Consequently, the strategy at Lake Tahoe must be undertaken within an adaptive management framework, wherein new knowledge is used to inform and update management decisions.

C. Asian Clam Management Phases

The framework that we have identified to design and implement a research-based, lake wide Asian clam management plan involves a four part program. This program includes the use of pilot project testing and re-testing in small isolated Asian clam infestations, observation and monitoring, and the use of this information to develop an informed long-term management strategy for Asian clam in Lake Tahoe. The four parts are: I) Field testing of removal options and identification of science needs, II) Evaluation of a recommended strategy for Asian clam control, III) Implementation of the control strategy, and IV) Long-term monitoring to evaluate success. **Actions taken in part III and part IV of this plan are contingent on findings from parts I and II given efficacy, timing and costs associated with pilot projects and internal and external reviews.** The steps with each part are outlined below.

There are currently three mechanical management operations under consideration for pilot testing: 1) diver assisted suction removal (to physically remove clams from lake sediments), 2) bottom barriers, or large impermeable sheets to cover and kill Asian clam populations by reducing oxygen and food availability—and 3) some combination of the two treatments. These management options were selected because of their non-chemical nature, their previous use in Lake Tahoe to treat Eurasian watermilfoil and Curly leaf pondweed. Diver assisted suction removal is not practical for removal of clams from extensive areas, as the depth of clam habitat (4 inches) will require the removal of too much material from the lake bed. This technique may, however, be useful for removing small patches of clams. Diver assisted suction may have greater use in removing surface deposits of dead clam shells. Pilot testing of diver assisted suction will therefore focus on removal of small patches and removal of surface deposits. Barriers are currently believed to hold the greatest potential for controlling clams in areas where they are present over large areas (acres). The focus of the pilot testing will be to determine the minimum length of time for which barriers need to be in place to kill clams by depletion of oxygen

and/or food supply, and methods for efficiently installing large areas of barrier material (hundreds of square meters).

There are five points of evaluation related to efficacy of the field pilot tests: 1) Does the use of diver assisted suction removal and/or bottom barrier installation and removal cause nearshore turbidity requirement to exceed minimum levels as defined by the regulatory agencies?, 2) What are the impact of the respective management strategies on the physical removal or mortality rates of live clam beds? 3) Does diver assisted suction dredging effectively remove surficial shell matter, thus reducing localized calcium sinks? 4) What is the logistical capability of the action, i.e., what is the rate of removal per unit area per unit effort? And 5) What are the long term consequences of the management action? Once the efficacy of the small scale pilot removal efforts has been evaluated, these or other management options will be assessed for the possible implementation at a larger scale (i.e., multi-acre and/or whole lake treatment). A detailed work plan for Part I will be developed prior to the commencement of pilot operations as part of the permitting process. This work plan will, however, be adaptive in nature and designed to be modified as the testing proceeds.

Additionally, the use of natural, mild molluscicides (e.g. potassium) will be explored as a non-mechanical option **in the laboratory** as a possible long-term control option. These experiments are to test the concentrations required for effective yet environmentally safe use in the field, as well as to collect information that will be critical to inform the approval process for use in Lake Tahoe.

Part I – Field Testing of Removal Options and Identification of Science Needs

Part I of the Lake Tahoe Asian clam management plan is to 1) evaluate the technical feasibility, application logistics and cost for the various control options, 2) determine specific monitoring and management needs, 3) assess the

feasibility for Asian clam control using pilot test plots (<1 acre), and 4) perform a quantitative analysis of efficacy of control methods. Part I is designed to inform the management and research team for longer term control and monitoring options. These actions are an assessment necessary to determine likelihood of success and strategy before whole-lake implementation occurs. At this time we anticipate actions to include:

a. Design and implementation of pilot removal operations

- Selection and implementation of areas to test diver assisted suction removal and bottom barriers. This includes the installation of silt curtains to minimize the impacts of increased sediment resuspension as well as the possibility for juvenile spread during the pilot stage
- Evaluate the ability of screens/sieves within the waste collection system to remove small (young) clams
- Determination of proper suction removal equipment required to operate effectively at Lake Tahoe
- Determination of most effective means of providing diver air (compressed air tanks or surface diver air compressor)
- Development of diver safety procedures including back-up diver(s), safety officer and emergency equipment
- Establish minimum equipment (boat, barge, hoist, clam/vegetation disposal) requirements for winter operation
- Establish minimum weather conditions for safe and effective removal operation
- Determine waste (clams etc.) disposal site
- Determine most efficient bottom barrier size, handling and material
- Establish maximum water depth for diver operations

b. Monitoring program to assess:

- Efficacy of the control technique in pilot areas– includes immediate monitoring of clam populations to quantify the removal effort by suction removal, barriers, etc. This will be based on number of clams removed, number remaining, dredge size selectivity, assessment of clam mortality.

- Impacts to lake water during operations (including the fate of dredge return water), changes to bottom substrate

- Recolonization of sites, colonization of new sites, and release of juveniles during treatment

- Asian clam population changes--Areal expansion, biomass growth and changing population densities in existing (non-treatment area) beds, includes impacts or suction removal on reproductive biology (release of juveniles into water)

- Environmental impacts as a result of Asian clam control—includes changes in nutrient flux, turbidity, dissolved oxygen, and benthic disturbance

- Efficacy of large scale removal, including water depth, acreage, disposal of large amounts (weight and mass) and personnel

c. Clam bed expansion from existing beds, lake wide distribution, development of novel technology

- We currently have an incomplete understanding of the rate of expansion of existing beds and their lake wide distribution (only aware of populations from Zephyr Cove to Pope Beach—west, north shores have not been surveyed). An understanding of lake wide distribution and their growth is critical to determine strategies for lake-wide control.

- Field testing of remote sensing technologies (such as sonar, high resolution photographic surveys by autonomous underwater vehicles, airborne lidar etc.) as a tool to rapidly assess large areas of the lake for the presence of clams. Such technologies are used elsewhere to detect fish egg masses and other biota in sediments; could provide a rapid and

effective means to survey for Asian clam presence on a large scale. If initial field tests determine that this survey method is effective, then a lake wide survey would be conducted. This will inform (f) below.

d. Clam population growth rate, food utilization, development of a growth model

- Understanding basic life history and clam energetics will be critical to determine the variability in their growth rates around the lake. We will quantify growth in existing patches and determine constraints (food, temperature, light, etc.) that may or may not be limiting their growth.

e. Habitat suitability of lake wide area

- A comprehensive, bottom sediment survey of environmental conditions has never been completed for the lake. This will be needed in order to assess which locations may establish clam populations.

f. Lake wide impacts at current or enhanced levels

- Impacts to the lake's ecology are unknown and likely vary based on the density of clams in a given locations. Changes to the open water (phytoplankton, clarity) and benthic communities are expected and could alter native fisheries. We will assess the potential for changes in clams of varying patch size.

- Impacts to drinking water systems--evaluation of nutrient or particle additions as a result of biofouling at intake pipes, possible impacts to non-filtration status (communications via Tahoe Water Suppliers Association (TWSA))

g. Facilitation by clams of other invasive species (e.g. quagga mussel) via the release of calcium from dead clam matter.

h. Laboratory testing of molluscicide treatments (effective dosages, impacts to clams, water quality, etc.)

i. Permitting, RFPs and funding (to be done by AIS)

- Permits will need to be written for the project by TRPA. TRPA staff within the Environmental Improvement Branch would be the lead planner for this permitting effort[1].

j. Outreach and education (see Section V)

Part II – <u>Evaluation of a Management Strategy for Asian Clam Control</u>

Once the pilot testing has been completed and efficacy and environmental impact have been reviewed, a preferred management strategy for Asian clam control can be selected. This process can include multiple (2-3) pilot test periods. This selection process includes input from the Lake Tahoe Asian clam management and research team, project stakeholders, and external reviewers:

a. Economic evaluation of lake wide management strategy

b. Report on the efficacy of pilot testing

c. Summary of all scientific findings to date

d. Lake Tahoe Asian clam work group and an external review panel will be convened to evaluate the potential based on the latest scientific information to determine the efficacy of removal strategies and effort. Information will be based on pilot test plot information, lake wide distribution, and information gathered to date.

e. Report on recommendation strategy and timetable for clam control

f. Evaluation of funding sources

g. Public and agency outreach

[1] The Asian clam management working group is currently working on permit issues. In addition to the members represented on this document, we will invite representatives from the CA State Lands Commission as well as California State Parks to ensure proper permitting.

Part III – <u>Implementation of expanded demonstration and/or lake-wide control actions</u>

Upon completion of Parts I & II, the Asian clam control and monitoring project could progress in one of two directions: a) the implementation of an expanded demonstration (larger than pilot test plots but at a smaller scale than whole-lake effort) of possible control strategies, or b) the implementation of the large scale, lake wide control plan. The selection of option a or b will be determined by the evaluation of economic and environmental cost in the pilot testing periods of phase 1 and 2, assessment by the external and internal review panels, and feasibility of implementation given timing (i.e., winter periods to minimize impact of Asian clam reproductive cycle, high frequency recreational boating periods, etc.). Phase 3a or phase 3b should occur at a time to minimize the impact of Asian clam reproductive biology on the success of the management strategy, and should include an important public and agency outreach and communication scheme. This cannot be implemented until feasibility of management strategy and lake-wide distributional data have been determined.

a. Implementation of recommended control strategies

b. Onsite monitoring of existing locations

c. Continued monitoring of control patches to determine recolonization, new colonization, benthic conditions, and water quality initiated in Part I.

d. Finalize research recommended from peer review panel.

e. Evaluation of efficacy of expanded demonstration/ lake wide control

f. External peer review panel to evaluate progress and recommendations

Part IV – *Long-term Monitoring to evaluate success*

To understand the impact of control strategies, a long term monitoring plan must be employed. This will include the observation and evaluation of:

a. Recolonization of Asian clam in areas where control strategies have been implemented

- Growth and population level changes both within and without management areas
- Includes both localized and lake wide survey

b. Sediment characteristics

- Changes to benthic areas as a result of Asian clam presence or removal (nutrient content, anoxia, calcium levels, etc.)

c. Colonization in novel, uncolonized areas

Water quality conditions including benthic and pelagic habitats, ties to stormwater, Asian clam related algal blooms

D. Timeline and Related Costs

The following section outlines a timeline related to cost estimates and detailed actions, as well as a public outreach and interagency communication plan for the four phase Asian clam management plan. It is important to recognize that funding availability can affect the priority of needs outlined in Parts I-IV above, and detailed in the table below. Our intent was to provide **the full suite of research needs as called for by a complete science plan.** The table in this section shows the phase schedule with details related to actions, items, and where funds have been applied from (SNPLMA and Nevada Division of State Lands Tahoe License Plate Round 12), and suggestions for where needed funding may come from (SNPLMA capital funds (Capital) and LRWQCB request

for urgency funds from the State Water Resources Control Board Clean up and Abatement Account (Abatement)). This table does not include funds already spent or research actions already completed.

Attachment A

TABLE 1. COST BREAKDOWN FOR FIVE YEAR PROJECT (PART 1, 2 AND 3 ARE TWO YEARS, PART 4 IS APPROXIMATELY 5 YEARS)

(Yellow highlighting indicates PART total with breakdown following)

ITEM	TIME SCHEDULE	COST
PART 1. Initial Management Response and Related Science and Monitoring Needs	**November 2008-November 2010**	**$1,398,400**
a. Initial Management Response	**November 2008-December 2009**	**$382,000**
i. Design pilot removal operations		$19,700[2]
• Suction removal • Bottom barriers		
ii. Conduct pilot removal operations		
• Operation costs		$90,000
• Equipment costs		$35,000
• Project management		$20,000
iii. Monitoring		
• Success of field removal operations		$18,200
• Immediate removal effectiveness		$21,800
• Impacts to lake water during operations		$20,000
• Change in bottom substrate condition following treatment		$18,200
• Survey for recolonization of *Corbicula*, other invasive species and/or native species following treatment		$48,000
• Release/survivorship of juveniles during treatment		$9,000
Operation costs (LAB CHEM COSTS 125 SAMPLES @ $150 each, boat time 50 hours@200,3000, supplies, computing, etc.)		$31,800
LAB OPERATIONS (UCD AND UNR)		$20,000
iv. Public outreach		$2,600
v. Agency coordination		$2,600
vi. Project administration		$11,200
vii. Reporting		$13,900

[2] These funds to come from remaining Bureau of Reclamation funding, granted to UC Davis and UNR May 2008

b. Science Needs for Decision-Making and to Develop an Informed Management Plan[3]	**November 2008 – November 2010**	**$1,016,400**
i. Distribution and location		
• Development/field testing of remote sensing techniques		$14,800
• Completion of distribution analysis for the southeast/south shores		$47,600
• Depth of clam burial in sediment		$11,100
• Lake-wide survey		$75,800
Operating costs including boat time (120 hours at $200 per hour), travel costs, bottles, etc., lab house in Incline (7.5 month at $1500 per month)		$38,300
Lake-wide survey remote sensing costs (Subject to field testing (side scan sonar, AUV, alternative technologies.: includes instrument field survey time, post-processing data analysis)		$130,000
ii. Characterization of *Corbicula* population growth		
• Clam bed range expansion monitoring		$16,300
• *Corbicula* fecundity/reproductive cycles and growth study		$19,700
• Determine rates of food usage (from both open water and sediment sources) and quantify how food available regulates growth and reproduction		$25,400
• Development of growth model based on food resources, water temperature, calcium concentrations, UV light conditions, etc.		$21,000
iii. Habitat suitability of lake wide area		
• Bottom substrate characterization (e.g. organic content, pore water chemistry, particle size distribution, macro-topography)		$24,200
• Surface current transport and wave action modeling		$96,000

[3] Scientific understanding of the Asian clam (*Corbicula*) in Lake Tahoe is currently inadequate to inform resource agencies and decision-makers in the Lake Tahoe Basin with a management plan for this invader that contains a reliable risk assessment for the various levels of treatment available. Since the time scale for the growth and development of these biological populations is on the order of many months to years, it is only reasonable that the important science needs be initiated as early in this program as possible to ensure that future management actions is guided by more a more complete understanding. The results of the recommended research and monitoring will be used throughout all parts of the management effort including immediate (year 1 – development of control approach), intermediate (years 2-3–implementation of control actions), and future (years four and beyond –evaluation of success and adaptive management).

• Environmental parameters related to establishment and growth (e.g. UV light, temperature, wave action)		$45,200
Funds for Jim Oris for UV Project		$50,000
Operating costs (includes boat time (45 hours at $200/hour), car travel, supplies @$8000)		$19,000
iv. Lake-wide impacts from current or enhanced levels of *Corbicula*		
• Localized stimulation of nuisance blooms of benthic algae		$34,500
• Impacts to in-lake phytoplankton, zooplankton, nutrients and lake clarity		$42,800
• Impacts on native benthic organisms		$20,400
Operating costs (bottles, 1 freezer, 1 incubation chamber, beakers, bags, sugar, boat time 50 hours @ $200/hour)		$17,000
v. Facilitated invasion of quagga mussels via calcium release from dead clam shells		
• Laboratory testing of survival, growth and reproduction using quagga mussels		$13,900
• Clam shell leaching experiments		$16,100
• Field sampling of lake water in direct contact with *Corbicula*		$17,100
• Assess need for shell removal following bottom barrier		$28,200
Operating costs includes boat time (36 hours at $200/hour), car travel, and supplies		$16,000
LAB OPERATIONS (UCD AND UNR)		$20,000
vi. Laboratory molluscicide testing and evaluation		$20,000
vii. Science coordination		$5,000
viii. Public outreach		$2,600
ix. Agency coordination		$2,600
x. Scientific project administration		$44,000
xi. Reporting		$81,800
PART 2. Evaluation of Strategy for Asian Clam Control[4]	**July 2009 – October 2009**	**$172,400**

[4] During this part of the management plan basin agencies, together with the in-basin science team and an external peer panel, selected because of their knowledge of *Corbicula* ecology and management, will use the existing information and risk assessment to

i. Economic evaluation for lake-wide management strategy		$30,000
ii. Preparation/participation and technical assessment by external peer review panel		$55,400
Panel costs		$40,000
iii. Report on Recommended Strategy and Timetable for *Corbicula* Control in Lake Tahoe[5]		$33,800
iv. Public Outreach		$2,600
v. Agency coordination		$2,600
vi. Project administration		$10,600
PART 3. Implementation of Expanded Demonstration and/or Lake-wide Control Actions	**November 2009 – October 2011**	**TBD**
i. Implementation of recommended control strategy either at an expanded demonstration scale in the beds located in the southeast portion of the Lake, or lake-wide as determined in Part 2		Cost estimate comes from economic report in part 2
ii. On-site monitoring during removal operations		$74,800
LAB CHEMISTRY COST: 200 SAMPLES@$150 each		$30,000
iii. Continued monitoring of recolonization, new colonization, benthic condition, and water quality status initiated in Part 1		$141,600
iv. Finalize research as recommended in Part 1b		No Budget Associated (Part 1b)
v. Evaluation of efficacy of expanded demonstration/lake-wide control each year		$44,200

determine the extent to which removal/control actions will be taken during the winter of 2009-2010. Tasks listed under Part 2 require the full completion of Part 1a and Part 1b to the extent possible.

[5] Produced cooperatively by the LTAISWG (and associated agencies), in-basin science team and external peer review panel.

vi. Annually, assemble external peer review panel to evaluate progress and discuss future actions Panel costs		$14,500 $50,000
vi. Public outreach		$2,600
vii. Agency coordination		$2,600
viii. Project administration		$24,700
ix. Reporting		$49,000

PART 4. Long-term Monitoring to Evaluate Success	**November 2011 – annually into the future**[6]	**$103,400**
i. Survey for recolonization of *Corbicula*, other invasive species and/or native species in and adjacent to the treated areas		$25,700
ii. Change in bottom substrate condition in treated areas		$27,300
iii. Lake-wide survey for *Corbicula* in previously un-colonized areas		$25,700
iv. Water quality conditions including pelagic and benthic habitats		$10,000
vi. Public outreach		$2,600
vii. Project administration		$2,600
viii. Reporting		$9,500

Table 2. Total amount requested from executive committee less other available funds **for initial two year period of proposed project (This includes Parts 1 and 2 ONLY)**

Amount requested and funding sources	**Value**
Total	$1,398,400
Total minus in kind matching (UCD and UNR)	$1,204,770
Total minus in kind matching and SNPLMA, NDSL funds (if granted)	$803,196
Total minus in kind matching and SNPLMA, NDSL funds (if granted), and remainder BOR funds ($23K)	$780,196
Total minus in kind matching and SNPLMA, NDSL funds (if granted), and remainder BOR funds ($23K) and Emergency funds ($25K)	$755,196
Total minus in kind matching and SNPLMA, NDSL funds (if granted), and remainder BOR funds ($23K), Emergency funds ($25K) and LRWQCB urgency requests from the State Water Board's Cleanup and Abatement Account ($100K for urgent suction removal and up to $100K additional urgent funds for research and monitoring). Requests >$100K from Cleanup and Abatement Account require State Water Board approval and could take several months to approve.	$655,196

[6] It is expected that long-term monitoring for i-iii will be needed on an annual basis for at least five years following treatment.

Ibid minus NDSL contributed funds ($125,000)	$530,196
Ibid minus U.S. Fish and Wildlife SNPLMA Round 9 funds ($100,000)	$430,196

E. Define Working Group and Partner Roles

The Asian clam working group combines a research team from UC Davis Tahoe Environmental Research Center (J. Reuter, G. Schladow, M. Wittmann) and University of Nevada Reno (S. Chandra) with a management team represented by members from the Tahoe Resource Conservation District (N. Cartwright and D. Roberts), the U.S. Fish and Wildlife Service (S. Chilton), the Lahontan Regional Water Quality Control Board (D. Smith), Tahoe Regional Planning Agency (T. Thayer, D. Oliver), Nevada Department of Wildlife (D. Catalano and K. Tisdale), Nevada Division of State Lands (E. Harrison). In the future, representatives from the California State Lands Commission and California State Parks will be involved in this project.

The research team (UNR & UCD) will provide scientific guidance and technical expertise regarding Asian clam biology, control and its relationship to the physical, chemical, and ecological properties of Lake Tahoe. UCD and UNR will conduct onsite monitoring and analysis of short and long term control treatments, field work including Asian clam presence/absence surveys, physical habitat characterizations, laboratory experimentation, and analysis of ecological data. As well as conducting the research described above, the research team may choose to collaborate with other research institutions when additional expertise is warranted.

The operations plan for Asian clam removal will be carried out cooperatively by U.S. FWS, TRPA, TRCD, and UCD and UNR. Initially TRPA will procure a diver-assisted suction removal unit and the TRCD will contract for the personnel and additional equipment required to facilitate the project. TRCD will also develop and implement a media and outreach plan. Specific locations in California and Nevada for the removal coinciding with research conducted by UCD and UNR will be determined and logistical considerations will be evaluated. Weather and contractor availability will determine the operational windows, but the project

will most likely proceed in January 2009 and continue for ten to twenty working days. Personnel will be contracted by the TRCD and will be under their contractual control. Suction removal equipment will be purchased and retained by TRPA and TRPA watercraft will be utilized during the operation. Project coordination will be facilitated by U.S. Fish and Wildlife Service (FWS).

Additionally, TRPA, in its role as the bi-state regulatory agency, will provide permitting for the project. The TRPA will also provide logistical support for the removal and monitoring effort, as well as assistance with public outreach and agency coordination. Lastly, the TRPA will work with state and federal agencies to provide funds for the project.

The role of the Nevada Division of State Lands (NDSL) in the Asian Clam Control and Monitoring Plan are several. The State of NV owns the lake bottom lakeward of elevation 6223.0 feet and therefore NDSL will need to provide temporary authorization for any work planned for pilot projects associated with Asian Clam control. The State of Nevada has a vested interest in assisting with Asian Clam control and therefore some financial assistance from NDSL will be provided for the pilot program. NDSL will assist in providing public outreach on these efforts where feasible and where resources are available. NDSL intends to provide authorization to another party to submit an application on behalf of NDSL to complete the clam removal work. It is expected that this party will be issued the TRPA permit rather than NDSL. NDSL will provide authorization for another party to complete the actual pilot activities on NDSL property.

NDOW will be able to provide limited on the ground assistance due to budget constraints and resources. NDOW can provide a barge (diver staging, material collection, etc.) if needed but will not have anyone available to man the vessel. In addition, the State of NV has a vested interest in assisting with the control of Asian Clam species and therefore will provide assistance when possible. NDOW

may be able to provide some outreach through the department webpage and conservation education program.

TRCD will manage outreach coordination with HOA's, presentations, development, etc. as specified in the table in section F. The TRCD will manage possible contracts, grants, and possibly permits. Finally, TRCD will assist in the coordination with agencies, CCC members, removal crews and scheduling related to removal pilot and demonstration projects.

LRWQCB will provide support for the project and request up to $100K from the State Water Board Cleanup and Abatement Account funds for the urgent suction removal and bottom barrier pilot projects. Additionally, LRWQCB will review, comment, and provide active involvement if the group pursues basin plan amendment to use molluscicides in Lake Tahoe[7].

[7] Molluscicides tested herein falls under the California Agricultural Code § 12753 definition of a pesticide. All laboratory testing of molluscicides will be directed toward assessing the application of these pesticides so as to not exceed the lowest detectable levels, using the most recent detection procedures available, no increases in pesticide concentrations in bottom sediments or aquatic life. Waters designated as MUN shall not contain concentrations of pesticides or herbicides in excess of the limiting concentrations specified in Table 64444-A of Section 64444 (Organic Chemicals) of Title 22 of the California Code of Regulations which is incorporated by reference into this plan. This incorporation-by-reference is prospective including future changes to the incorporated provisions as the changes take effect.

F. COMMUNICATION SYSTEM

The management of Asian clam in Lake Tahoe will require a communication system whose goal to increase awareness of Asian clam presence, control and removal. The general objective is to reduce the public's negative response to clam removal and to keep agency representatives and other stakeholders informed of all actions taken. The table below summarizes means of communication and associated costs.

Objective	**Target Audience**	**Message**	**Format**	**Distribution**	**Cost Estimate**
Alert and increase awareness of removal plans to reduce negative response	Nearby property owners	• Clam removal will occur on dates: XX • Reasons for and possible impacts	Printed mailer	US Postal Service	10 hrs TRCD= $340 30 hrs AC= $0 3 hours review TRPA= $87.06
	Basin residents	" "	Press release	Newspaper	4 hrs TRCD= $136 12 hrs AC 3 hrs TRPA=$87.06
	Boaters	" " • Check equipment for AIS	• Brochures • Notifications at marinas and launch sites	Hand out by watercraft inspectors, marina staff, postings at launches	4 hrs TRCD= $136 12 hrs AC 3 hrs TRPA=$87.06
	Visitors	AIS impact Lake Tahoe	Exhibits, posters	• UC Davis Thomas J. Long Foundation Education Center • Tahoe Maritime Museum • Explore	20 hrs TRCD= $680 30 hrs AC 5 hrs TRPA=$145.10

Attachment A

Objective	Target Audience	Message	Format	Distribution	Cost Estimate
				Tahoe	
Information sharing regarding control implementation	Agency staff	Removal updates	• PDF memo • Meetings	• List serve (e.g. clamlist@ucdavis.edu) • Monthly meetings with agency participants to disseminate information	25 hrs TRCD= $850 10 hrs TRPA=$290.20
	Tahoe Water Suppliers Association (TWSA)	Communication and meetings regarding water intakes, monitoring plans, biofouling, etc.	• Meetings, emails	• Meetings with TWSA participants to disseminate information	

Attachment B

Scope of Work--Surveying Emerald Bay to delineate the extent of Asian clam population

A. Significance

The Asian clam research team has discovered Asian clam beds in Emerald Bay, Lake Tahoe. Asian clams are known to be aggressive invaders that have significant environmental impacts. Through Lake Tahoe field surveys, laboratory experiments, and literature reviews conducted since April 2008, UCD and UNR researchers have found that Asian clams 1) excrete elevated levels of nitrogen and phosphorus into the water column and sediment substrate, 2) filter high volumes of water, and 3) have a strong correlation to the growth of large, nuisance blooms of bottom-dwelling, filamentous algae in the nearshore environment.

Potential impacts of natural exponential increases of this species, lake-wide, include degraded water quality, decline of pelagic phytoplankton and zooplankton communities, disruption to Lake Tahoe sports fisheries, increased levels of calcium through the concentration of dead shell matter with a possible promotion of other invasive species, and a successful out-competition Lake Tahoe's native benthic species such as the montane pea clam (Pisidium spp.) and the ram's horn snail (Planorbidae). Taken together, all the possible impacts further separates Lake Tahoe from its desired condition of a pristine, ultra-oligotrophic lake.

Given these potential impacts, there is increasing focus by resource managers and researchers to develop an effective management strategy of Asian clam populations. Features of this management strategy includes 1) identification of existing clam populations on both a localized and lake-wide scale, 2) understanding the growth potential and reproductive strategies of Asian clam, 3) predicting their capacity to spread and colonize new habitats, and 4) control of existing populations.

B. Objective

A fundamental need for developing a feasible management strategy for Asian clam is the delineation of population extent. Since the Asian clam were seen in increased numbers in April 2008 the science team has extensively mapped out their distribution in the Marla Bay area, conducted surveys along the South Shore, and most recently (August 2009) employed an autonomous underwater vehicle (AUV) to do a lake-wide survey, and have carried out an initial scuba survey in Emerald Bay in 2009 to delineate the extent of Asian clam populations.

This proposed scope of work presented herein comprises the survey to determine the extent of the Asian clam infestation in Emerald Bay and define, if any, the change in previously delineated Asian clam areas in the Bay. This survey is intended as a continuance of the monitoring of the Asian clam population in Emerald Bay with the intent to implement Asian clam population control strategies (such as the installation of bottom barriers). This project is complimentary to the Asian clam Removal Pilot Project administered by TRCD, partially funded by Lahontan RWQCB Clean Up and Abatement funds and Nevada Department of State Lands License Plate funds.

C. Work to be Performed

Research divers from UC Davis (and associated trained volunteers) will conduct a SCUBA survey of the entire littoral zone of Emerald Bay in an effort to identify the extent of Asian clam

beds in Autumn 2010. This will be accomplished by 1) making visual observations of shells on the surface and 2) having the dive team manually search for clams buried just below the surface by running their fingers through the soft sediment and feeling for clams. The survey will be carried out along a 3-meter and a 5-meter contour. These contours were selected because the current knowledge of Asian clam presence in Emerald Bay is at a 3-meter depth, and the bulk of Asian clams in Lake Tahoe proper are currently believed to be at a 5-meter depth. The SCUBA survey will take place over a two-week period to ensure suitable weather conditions. Approximately seven days of SCUBA survey are required to cover the nearshore perimeter of Emerald Bay. Researchers will take GPS coordinates and place bottom markers at the edges of clam beds and will quantify the areal coverage of this region and produce a map.

The survey will determine the spatial extent of clams in Emerald Bay, provide a quantitative baseline to evaluate future conditions, and give needed information for developing a control program.

D. Budget

Emerald Bay SCUBA dive survey (September-October 2010)

Boat	
Use of R/V Bob--8 days	$8,000
Staff	
Marion Wittmann (20 days)--includes planning, diving, reporting	$3,167
Brant Allen (10 days)	$2,167
TERC staff (support, drive time to Reno for dive tank refills--8 days)	$1,133
Equipment	
Rope and rebar (for semi-permanent staking of area)	$600
Dive tank refills	$200
Travel to Reno for dive tank refills/equipment needs	$500
Dive equipment (misc)	$2,000
Support for volunteer divers	$500
Support to hire AAUS certified divers	$3,500
Direct Cost Total	$21,767
Indirect Costs (26% UCD rate)	$5,659
Total Cost	**$27,426**

Budget justification

The Emerald Bay dive survey took 6 days to complete in 2009, and the 2010 survey is expected to take two more days to complete than in 2009 because of the extra task of staking and marking off the area with rebar and rope. Therefore, 8 days of UC Davis boat time at $1000 per day will be used. Marion Wittmann and Brant Allen of UC Davis will spend 20 and 10 days respectively planning, preparing and carrying out the dive survey which will include equipment maintenance, correspondence with California State Parks, diving, and recruiting volunteer and paid AAUS-certified divers. Travel and equipment costs plus hourly rates ($200/hour) incur $3500.

Attachment C

Asian clam rubber bottom barrier project description: Emerald Bay, Lake Tahoe

1. Introduction and Overview

The growth and expansion of Lake Tahoe Asian clam (*Corbicula fluminea*) populations and associated filamentous green algal blooms in 2008 has instigated a coordinated basin wide effort for the management and control of these species. A pilot project to remove and monitor Asian clam in Lake Tahoe has been facilitated by a number of institutions, with UC Davis and UN Reno to provide ecological and biological research and evaluation of the removal strategies.

In 2009, the Asian clam working group (ACWG) which is comprised of members from UC Davis Tahoe Environmental Research Center (UCD-TERC), UN Reno (UNR), Tahoe Resource Conservation District (TRCD), US Fish and Wildlife Service (USFWS), Lahontan Regional Water Quality Control Board (LRWQCB), Tahoe Regional Planning Agency (TRPA), California Department of Parks and Recreation (CDPR), Nevada Division of State Lands (NDSL), and Nevada Division of Wildlife (NDOW) have met regularly to discuss, plan and implement a pilot project to experiment with non-chemical treatment strategies for Asian clam treatment in Lake Tahoe. In two sites within Lake Tahoe (Marla Bay and near the Lakeside Marina) small scale experimental applications of 45 mil, rubber pond liner sheets were placed over Asian clam beds. These rubber bottom barriers created a zero dissolved oxygen environment underneath the sheet, and after an approximate 30 day period at peak summer lake temperatures (16-19 °C) caused Asian clam and other benthic macroinvertebrate mortality. The ACWG feels that this small scale pilot project yielded potential for the use of rubber bottom barriers as a treatment method in Lake Tahoe. A scaled-up version of the initial pilot project experiment is scheduled to be installed at two sites (Marla Bay and near Stateline in 5 m water depth) in Lake Tahoe in 2010. The purpose of this installation is to understand the logistics, cost effectiveness, impacts to Asian clam and other benthic macroinvertebrates, and the recolonization rates of these species on a large scale, with regard to the potential use of bottom barriers as a viable treatment for the reduction of Asian clam and associated algal blooms. The Emerald Bay bottom barrier installation is to further understand the 2010 pilot project factors, but also to experiment with additional logistical obstacles that are unique to Emerald Bay such as sloped and cobbled lake bottom, and the unusually high level of recreational boater traffic that travels through the known Asian clam populations. Emerald Bay is a unique habitat that will provide distinct challenges to this potential control strategy application.

In 2009 a small population of Asian clam were discovered in Emerald Bay by the UCD-UNR science team. The population is located near Eagle Point, at the mouth of Emerald Bay in approximate water depths of 2 to 10 meters. The estimated area of the infestation is ¾ to 1 acre and population densities are low.

The following is the experimental design for rubber bottom barrier implementation for the purpose of reducing Asian clam densities in Emerald Bay.

2. Project site selection

Through the Gavia autonomous underwater vehicle (AUV) lakewide survey carried out in August 2009 and a SCUBA survey in September and October 2009 around the perimeter of Emerald Bay, the entry channel, the nearshore regions directly outside of the bay, as well as

areas at D.L. Bliss State Park, the science team has observed Asian clam presence in a discrete region of Emerald Bay (Figure 1).

Figure 1. Near Eagle Point in Emerald Bay, Lake Tahoe. The red lines with yellow markers indicates the approximate areal coverage of the Asian clam population in Emerald Bay. Results from UCD-TERC scuba survey, September-October 2009.

The area marked in Figure 1 indicates the area which is infested with Asian clam, and subsequently, the proposed area to be treated with rubber bottom barrier. To account for possible changes in population size and structure, another SCUBA survey of the Emerald Bay clam beds is proposed for October 2010.

Emerald Bay provides logistical issues in terms of the installation and application of rubber barriers. These include: 1) a sloped bathymetry of the lake in the Asian clam area, which presents difficulties for the installation and removal of rubber sheeting, 2) cobble and rock substrate that can complicate proper placement of the barriers, and 3) high recreational and commercial boat traffic.

3. Project description

The application of a large scale area of rubber bottom barriers will be carried out in July 2011 with a proposed start date of May 1st and an estimated end date of July 28. The major field actions to occur during this time include: a) a field delineation of the project area site, b) baseline condition sample collection, c) delivery of rubber materials from land to field site, d) placement of rubber material at field site (underwater), and e) removal and decontamination of the barrier material. The following is a description of each of the five major actions.

a. Field delineation of the project area site

An approximate half acre area will be marked underwater using rebar stakes and 3/8 inch nylon rope at the Emerald Bay site. The stakes will be hammered into the bottom substrate and the nylon rope will be tied to the stakes along the lake bottom—all materials will be directly upon the lake bottom except for site indicator subsurface floats placed on the corners of the field delineation site that will be 1 meter above the bottom (4 meters below the water surface). This area will help to guide the placement of the bottom barrier application and guide the science team for regions to collect baseline and ongoing monitoring samples. The field site delineation will occur in May by the UCD-TERC and UNR science team.

b. Baseline condition sample collection

We will carry out a pre-application characterization of benthic macroinvertebrate communities at the two sites by benthic grab sampler (PONAR) as well as SCUBA-based sampling for sediment porewater nutrient content and sediment algal content (seston). Specifically we will collect 30 PONAR samples in and around each ½ acre treatment area to identify the abundance and biodiversity of the benthic macroinvertebrate communities in these areas, and to characterize the Asian clam populations (and surrounding clams as sources for recolonization) bordering these areas. The PONAR sample locations will be in regular distances from the "edge" of the delineated barrier plot to the center, as well as along the fringe of the plot. This monitoring will occur (at a reduced sampling rate hereafter) immediately after bottom barrier removal and quarterly for a one year period.

c. Delivery of rubber materials from land to field site

In each ½ acre plot there will be a total of twenty 100 foot long by 10 foot wide 45 mil rubber sheets placed, overlapping upon each other for a continuous area. Because there are two field sites, there will be a total of 40 of these sheets transferred to a barge and delivered to the lake. These sheets must be prepared on land for application in the lake and this includes: rolling the sheets onto PVC pipe cores for diver ease of handling, preparing the edges of the rubber sheets for underwater securement as well as for removal procedure after the application period is complete. Once the preparation stage is complete, the rubber barrier material will be transferred to a barge and delivered to the field site. The estimated need for barge time is 14 to 28 days.

d. Placement of the rubber material at the field site

The rubber materials and associated weights (rebar rods and/or chain link) for the rubber sheets will be lowered to the lake bottom either from the side of the barge using a winch

or backhoe. The materials will be lined up along the edge of the delineated field site. Float bags will be secured to the rubber barrier material underwater to reduce the weight of each rubber barrier roll. The rubber barriers will be rolled out underwater by divers. It is estimated that approximately 6 divers per day for 4 days (3 hours each in water, 4 in water at any one time) is required for this task. After the rubber barriers are rolled out, the edges and seams of the rubber treatment site will be covered with rebar and other weights; it is estimated that this task will take 3 days (total of 6 divers all day, 3 hours each in water, 4 in water at any one time).

e. Removal and decontamination of rubber material

After a 50 day period, the rubber bottom barriers and all associated materials will be removed from the lake bottom. The initial step in this process is to remove all weights from the field treatment site. It is estimated this task will take 3 days (total of 6 divers all day, 3 hours each in water, 4 in water at any one time). The next step is the removal of each rubber barrier sheet. A diver will attach the edges of each sheet to a rolling system that will be operated from the barge. The rolling system will draw the sheet as it rolls it up from the bottom of the lake and will require no diver labor other than attachment and monitoring for proper recovery. After all barriers and weighting materials are removed from the lake bottom, they will be delivered to a land site for decontamination and preparation for any future application. Decontamination will occur using high pressure, high temperature (140°F) wash stations to remove any clam, algal or other biological material that may be transmitted between sites or foul the storage area.

Rubber implementation (For one acre of rubber in Emerald Bay)	Cost	Indirect cost (26% UCD)	Total (Indirect plus direct cost)
Monitoring			
Ponar sampling pre-barrier application (1 time)	$ 20,000	$ 5,200	$ 25,200
Ponar sampling post-barrier removal (once immediately aftewards and quarterly for 1 year period)	$ 45,000	$ 11,700	$ 56,700
Dive assessment of post-barrier removal site	$ 5,000	$ 1,300	$ 6,300
Total	**$ 70,000**	**$ 18,200**	**$ 88,200**
Labor--installation			
Rubber rolling out and prepping for field deployment at south shore site (2 hired laborers + truck rental)	$ 2,600	$ 676	$ 3,276
Field delineation of rubber sites (Brant, Marion, Line)--four days of boat time + dive time + line	$ 4,000	$ 1,040	$ 5,040
Truck transport from South shore site onto barge (2 hired laborers + gradeall forklift rental)	$ 4,800	$ 1,248	$ 6,048
Dump rubber from barge to underwater site (Daret and Bill + Barge employees--salary costs below, barge employees included in barge fee)	$ -	$ -	$ -
Arrange/place rubber rolls underwater, secure, prep to be rolled out (2 days, 6 divers all day (3 hrs each in water), 4 in water at any 1 time)--hired diver rate: $200/hour	$ 19,200	$ -	$ 19,200
Rolling out rubber mats underwater (4 days, 6 divers all day (3 hours each in water), 4 in water at any 1 time)--hired diver rate: $200/hour	$ 38,400	$ -	$ 38,400
Cover edges and seams with rebar, other weights (4 days, 6 divers all day (3 hours each in water), 4 in water at any 1 time)--hired diver rate: $200/hour	$ 38,400	$ -	$ 38,400
Total	**$ 107,400**	**$ 2,964**	**$ 110,364**
Labor--removal			
Total (Same as installation + $10K for decontamination by TRCD staff)	**$ 117,400**	**$ 2,964**	**$ 120,364**
Materials--installation			
Dive gear (UCD costs--air tank fills, rentals, misc dive gear, repairs, decon)	$ 4,000	$ 1,040	$ 5,040
Total materials	**$ 4,000**	**$ 1,040**	**$ 5,040**
Design, installation and project planning			
Bill Sluis and Daret Kehlet (50 days)	$ 24,485	$ 6,366	$ 30,851
Marion Wittmann (1.5 months)	$ 7,410	$ 1,927	$ 9,337
TERC staff (Katie Webb 1 month)	$ 4,420	$ 1,149	$ 5,569
Brant Allen (1 month)	$ 6,500	$ 1,690	$ 8,190
Sudeep Chandra (0.5 months)	$ 3,965	$ 1,031	$ 4,996
UNR staff (1 month)	$ 4,420	$ 1,149	$ 5,569
John Reuter (0.5 months)	$ 5,265	$ 1,369	$ 6,634
Geoff Schladow (0.5 months)	$ 6,581	$ 1,711	$ 8,292
Total	**$ 63,046**	**$ 16,392**	**$ 79,438**
Barge Time			
Deployment (14 days)	$ 44,800	$ -	$ 44,800
Removal (15 days)	$ 48,000	$ -	$ 48,000
Total Barge	**$ 92,800**	**$ -**	**$ 92,800**
Travel	**$ 3,000**	**$ 780**	**$ 3,780**
Contingency	**$ 15,000**	**$ -**	**$ 15,000**
Project Administration			
Buget Tracking TRPA	$ 4,089	$ -	$ 4,089
Compliance Monitoring Costs	$ 4,000	$ -	$ 4,000
Permits	$ 1,500	$ -	$ 1,500
TRCD Project Administration	$ 17,830	$ -	$ 17,830
TRCD Project Oversite and Management	$ 5,400	$ -	$ 5,400
TRCD Project Reporting	$ 5,400	$ -	$ 5,400
Total Project Administration	**$ 38,219**	**$ -**	**$ 38,219**

	Direct	Indirect	Total
Total Project Cost	**$ 518,954**	**$ 42,340**	**$ 561,294**