Proposal Full View

Applicant Information

Organization Name: University of California, Berkeley
Tax ID: 946002123

Proposal Name: Field test of a novel wetland treatment system to provide clean water for the Salton Sea Species Conservation Habitat

Proposal Objective:
The objective is to provide proof-of-concept for an innovative constructed wetland water treatment system (CWTS) developed at UC Berkeley for providing clean water to the SCH and other habitat related projects. This will be done by conducting field tests using a pilot CWTS constructed at a site adjacent to the Alamo River. In addition we propose to test different management strategies to enhance the removal of Se, especially through the environmentally-friendly Se volatilization pathway.

Budget

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Geographic Information

Latitude: 33° 11' 56"
Longitude: 115° 35' 57"
County: Imperial
Ground Water Basin: Location
Hydrologic Region: Geographic Information

https://www.bms.water.ca.gov/BMS/Agency/ProposalFullView.aspx 9/7/2012
**Watershed**

### Legislative Information

| Assembly District | 80th Assembly District *
| Senate District   | 40th Senate District *
| US Congressional District | District 51 (CA) *

### Project Information

| Project Name | Field test of a novel wetland
| Implementing Organization | University of California, Berkeley
| Secondary Implementing Organization | 
| Proposed Start Date | 1/1/2013
| Proposed End Date | 12/31/2015
| Project Scope | (Included in work plan Attachment 4)

#### Project Description

Our goal is to develop a novel constructed wetland water treatment system (CWTS) for the removal of Se, fertilizer nutrients and other contaminants from river water so as to provide a clean water supply for the SCH and other habitat related projects. This novel CWTS design has been successfully tested at UC Berkeley using mesocosms. The proposed research is to establish proof-of-concept under field conditions using a pilot CWTS located at a site adjacent to the Alamo River. The pilot CWTS will consist of a sedimentation basin, an algal treatment cell and a high density cattail treatment cell arranged sequentially. The function of the algal cell is to remove fertilizer nutrients and Se, a significant portion of which will be volatilized (volatilization leads to a net loss of Se from the local ecosystem, preventing its entry into the food chain). As the water containing Se-bearing algae flows into the cattail cell, more Se will be volatilized microbially by decomposition of algae and other organic matter; residual Se in the cattail cell will be immobilized in the sediments. With respect to the algal cell, its efficiency will be optimized by selecting the most suitable algal species and by manipulating growing conditions. The cattail treatment cell will be optimized by increasing...
the depth of the fallen litter layer to maximize an even flow of water through the Se-capturing sediment matrix, and by determining the residence time needed to reduce Se concentrations in the outflow to less than 1 µg Se/L. The efficiency of Se and fertilizer nutrient removal will be determined by measuring the inlet and outlet Se, N, P and S concentrations for each treatment cell. In order to ensure a sustainable and ecologically safe ecosystem, the potential bioavailability and toxicity of any residual Se accumulating within the CWTS ecosystem will be monitored by x-ray absorption spectroscopy of the various Se species in sediments, plants and wildlife.

Project Objective

The objective is to provide proof-of-concept for an innovative constructed wetland water treatment system (CWTS) developed at UC Berkeley for providing clean water to the SCH and other habitat related projects. This will be done by conducting field tests using a pilot CWTS constructed at a site adjacent to the Alamo River. In addition we propose to test different management strategies to enhance the removal of Se, especially through the environment-friendly Se volatilization pathway.

Project Benefits Information

Budget

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Geographic Information

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Longitude/Latitude Location
County Imperial Ground Water Basin Hydrologic Region WaterShed

Legislative Information

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Section : Project General Information Questions

Q1 - Project Type

Select the project type from the dropdown list.
Research

Q2 - Project Description

Briefly summarize the proposed project (4,000 characters limit). Include the following information: project goals and objectives, project location, proposed work to be funded, proposed approach (overview of techniques and methods), anticipated timeframe, and anticipated benefits.

The goal is to establish proof-of-concept for an innovative constructed wetland water treatment system (CWTS) to provide a supply of clean water to the SCH and other habitat related projects. A pilot CWTS (i.e., a sedimentation basin and 16 treatment cells) will be constructed by the Imperial Irrigation District next to the Alamo River. The objectives are to maximize the efficiency of Se and fertilizer nutrient removal by algal and cattail treatment cells arranged sequentially, to mitigate Se ecotoxic risk by enhancing the removal of Se to the atmosphere through Se volatilization, and to fully characterize (i.e., speciate) the chemical forms of any residual Se retained by the CWTS ecosystem. The research, which will take 3 years to complete, will provide a reliable, low-cost technology for generating a clean, low-salt water supply for species conservation habitats as well as an accurate assessment of the extent to which Se ecotoxicity has been mitigated by enhancing Se volatilization.

Q3 - Applicant Contact Information

Provide contact information (name, organization, phone number, and address) for the individual who would be the primary contact regarding the grant proposal.

Prof. Norman Terry, nterry@berkeley.edu University of California, Berkeley 111 Koshland Hall Department of Plant and Microbial Biology, University of California, Berkeley, CA 94720-3102
Tel: 510-642-3510; Fax: 510-642-4995
Q4 - Project Team Qualifications

Identify and describe your project team, including any partnerships with nonprofit groups, citizens’ groups, non-governmental organizations, and public or governmental agencies. Identify the proposed Project Manager/Principal Investigator (PM/PI) and key staff as well as the corresponding roles of team members. Provide a brief biographical summary for the PM/PI and each of the key staff members. An organization chart and copies of resumes can be entered in subsequent fields.

1) University of California Berkeley research team Principal Investigator: Norman Terry
Professor Norman Terry will be the manager and the main person responsible for conducting the research project and coordinating research activities with Dr. Bruce Wilcox and his colleagues at the Imperial Irrigation District (IID). As the Principal Investigator for the research at UC Berkeley, he will lead a team of three postdoctoral scholars and several research assistants in carrying out the proposed experiments, analyzing the data and preparing reports for the funding agencies, IID and CADWR. Prof. Terry is a world leader in the environmental remediation of heavy metal and metalloid pollutants in water and soils. He has led four major constructed wetland projects for the cleanup of agricultural and industrial wastewaters: the Allegheny Power Service Constructed Wetland at Springdale, Pennsylvania, the Tennessee Valley Authority Constructed Wetland at Widows Creek, Alabama, the San Francisco Bay Constructed Wetland Treatment System at Richmond, California, and the Tulare Lake Drainage District Wetland at Corcoran, California. Prof. Terry pioneered the use of constructed wetland water treatment systems for the removal of Se from agricultural irrigation drainage water, research which continues to this day and has led to the current project. More details on his extensive scientific publications describing such projects are found in the attachments section together with his CV (Attachment 3). Postdoctoral scholar 1: Dr. Jung-Chen Huang is a wetland engineer/ecologist. He obtained his Ph.D. from Ohio State University in Columbus in 2010. Since joining the Terry Lab, Dr. Huang carried out research on the project ?University of California Berkeley Salton Sea Research? sponsored by the CADWR. During the past 2 1/2 years, Dr. Huang has carried out mesocosm studies, the purpose of which was to develop a "second generation" constructed wetland water treatment system with the ability to reduce Se to extremely low levels (Huang et al., in press. Environmental science & Technology) (see Attachment 3 for his CV). Dr. Huang has the major responsibility for implementing the field research program to establish proof-of-concept of the proposed design of the constructed wetland treatment system (CWTS) to provide clean water to the Species Conservation Habitat. Postdoctoral scholar 2: Dr. Soo In Yang is a microbiologist and expert in the field of synchrotron-based technologies (x-ray absorption spectroscopy). Dr. Yang obtained his Ph.D. from the University of Saskatchewan in Canada in 2011, where he conducted research in microbial Se transformation in biofilms. His research centered on the mechanisms by which biofilms detoxify bioavailable Se forms present in water (see Attachment 3 for his CV and list of publications). Dr. Yang will contribute his synchrotron-based research expertise in the characterization of Se species contained in the different wetland ecosystem components in order to determine their potential bioavailability. Research and management support: Dr. Maria C. Suarez is the laboratory manager under the supervision of Prof. Terry. Her function in this project will be to provide logistical support of the research activities. Dr. Suarez will also help in the preparation of reports for the funding agencies. 2) Research Partner - Imperial Irrigation District Dr. Bruce Wilcox is the Environmental Program Manager for the Imperial Irrigation District (IID), Water Department, Agricultural Water Management Section, Environmental Mitigation Unit located at IID Operation Headquarters, J-15 in Imperial California. IID has generously agreed to fund the construction and participate in the operation and maintenance of the pilot CWTS described in this proposal. IID will provide the
Q5 - Related Experience

Describe your experience with completing this type of project or similar projects within the scheduled timeframe and within the allowable budget. Provide a description of recently completed or ongoing projects that support your team’s ability to perform the proposed work.

Prof. Terry has conducted four major studies involving the use of constructed wetlands for the cleanup of agricultural and industrial wastewaters. As principal investigator of each of these projects, he designed experimental research programs, secured the funds to support the research, hired the scientific personnel needed to conduct the projects, supervised the conduct of the research program and the analysis of the results obtained, prepared reports and published scientific papers associated with the work (see Attachment #3, Norman Terry Selected Publications). All this was done on budget and on time. Four field wetland studies done by the Terry Lab are described below. 1) The Chevron Wetland: In a joint project with the Chevron oil company, the Terry Lab conducted research on a 90-acre site at the Chevron oil refinery, Richmond, California. This study showed that constructed wetlands can remove a very high proportion of Se contaminants (mainly selenite-Se) from oil refinery wastewater. Inflow Se concentrations of 20 to 30 ?g Se/L were reduced to less than 5 ?g Se/L in the outflow. The wetland was able to process approximately 2 to 3 million gallons of refinery effluent per day. This study revealed that 20 to 30% of the toxic Se entering the wetland was released to the atmosphere in non-toxic volatile forms, a process known as ?biological volatilization?. This is an extremely important pathway of Se removal since Se removed by volatilization cannot enter the local food chain. 2) The Tulare Lake drainage district wetland at Corcoran: The success of the research at the Chevron wetland led to our next wetland project at Corcoran, 60 miles north of Bakersfield. In this experiment, we built 10 quarter-acre wetland cells to test the idea that constructed wetlands can be used to solve one of the most serious problems confronting agriculture in California, i.e., the problem of what to do with Se-contaminated irrigation drainage water. Huge amounts of Se-contaminated water are being accumulated in thousands of evaporation ponds throughout California and other western states. Agricultural drainage water differs from industrial wastewater in that it is highly saline and contains several toxic metals in addition to Se. Each of the 10 wetland cells was planted with different plant species in mono- and mixed-cultures to determine the best plant species composition for maximum Se removal. The best of these wetland cells removed 85% of the Se from the inflow as well as removing strontium and vanadium. 3 & 4) Tennessee Valley Authority and Allegheny Power Services wetlands: Electric utilities are mandated by the Clean Water Act to clean up their aqueous discharges. We carried out two separate studies, one at the Tennessee Valley Authority wetland in Alabama, and the other at the Allegheny Power Services wetland in Pennsylvania. The goal of this research was to develop optimal design criteria for building constructed wetlands. Both wetlands were shown to be capable of removing substantial amounts of toxic heavy metals including Mn and Fe, with the removal efficiency often exceeding 90%. Our most recent research (April 1, 2010 - present day) was conducted in response to a request from, and funded by, the California Department of Water Resources. The purpose of the research was to develop a design for an innovative constructed wetland water treatment system to remove Se and fertilizer nutrients from river water in order to provide clean water for the Species Conservation Habitat at the Salton Sea. The first manuscript reporting on this research has now been accepted for publication in a peer-reviewed journal (JC Huang, E Passeport and N Terry, 2012; Development...

Section : Habitat Creation And Enhancement Project

Q6 - Project Type

Is your Project a Habitat Creation and Enhancement type of project? If it is go to question #2 of this section. If not, go to the appropriate project type section to complete your application.

1) ☐ Yes  
2) ☐ No

Q7 - Project Goals and Objectives

State the habitat restoration goals and objectives of the proposed project. These should be simple, objective statements about what the proposed project seeks to accomplish over the near and long term. The objectives should be measurable and consistent with the Program goals identified in the guidelines. Include a description of performance metrics that could be used to measure the effectiveness in achieving the stated goals and objectives.

Q8 - Proposed Habitat Creation or Enhancement

Describe the habitat proposed for creation or enhancement. Include a description of the anticipated features and characteristics of the created or enhanced habitat (such as acreage, water depth, salinity, vegetation cover) upon completion of project construction as well as the characteristics of the habitat when fully established. Indicate the timeframe for achieving full establishment of the habitat.

Q9 - Current Site Conditions

Describe the current conditions at the site proposed for habitat creation or enhancement and the immediate vicinity. Include information on land ownership and characteristics such as land use, topography, soils and sediments, vegetation, wildlife usage, drainage patterns, contaminants, and any other features pertinent to the proposed project. The description should be sufficient to demonstrate that the site is suitable for the proposed project. Indicate whether the site is occupied by State- or federally listed species or species of special concern. Attach a location map and any photos or figures that illustrate the current condition of the site on the “Site Map and Photos” section of the application under the tab labeled “General Information and Attachments.”

Q10 - Proposed Approach
Generally describe the approach for implementation of the proposed work. Include information on grading, water conveyance, planting, invasive plant removal, erosion control methods, and other key features of the proposed work. Indicate whether the proposed techniques have been successfully implemented at the Salton Sea or in a similar environment. Demonstrate that the best available science has been incorporated into the design.

Attach design drawings and other graphical information related to the design on the “Design Drawings and Figures” section of the application under the tab labeled “General Information and Attachments.”

Also attach a Work Plan, Budget, and Schedule as described on the “General Information and Attachments” tab of this application.

Q11 - Project Benefits

Describe the anticipated benefits to be provided by the proposed project and explain how the project would further the goals of the Program. Indicate the species that the habitat is intended to support and describe the relative contribution the project would make in supporting the priority fish and wildlife described in the guidelines. If applicable, describe how the proposed project would benefit adjacent habitat or provide connectivity among existing habitats. Also, describe future actions, if any, needed beyond the scope of this project to fully address the overall project goals.

Q12 - Operations and Maintenance (O&M)

Generally describe how the project would be operated and maintained over time. Include a description of periodic maintenance activities that would be required, an estimate of projected costs, and a description of the frequency and timing of activities such as water management, vegetation management, sediment removal, and other O&M activities relevant to the proposed project. Indicate who would perform long-term maintenance and describe how the O&M would be funded. The applicant will be expected to prepare a detailed O&M Plan for the project, which should be included as a task component of the Work Plan and Budget.

Q13 - Monitoring and Adaptive Management

Generally identify the areas of scientific uncertainty associated with the project and describe the plan to adaptively manage the habitat to achieve the project goals and objectives. Describe the monitoring that would be conducted to measure performance and inform adaptive management adjustments in the future.

The applicant will be expected to prepare a detailed Monitoring and Adaptive Management Plan for the project, which should be included as a task component of the Work Plan and Budget. The plan will be for a minimum of 5 years. Monitoring reports are to be submitted annually to DFG. Funding for implementation of the first 2 years of monitoring under the plan can be included in the applicant’s budget. Indicate the funding source for the monitoring and adaptive management beyond the initial 2 years.

Q14 - Phasing
Indicate whether and how the proposed work might be phased or reduced if the project is funded at a reduced level. Explain how project benefits and total cost of the project would be affected if portions were deferred to later years. Also, describe the extent to which the proposed habitat could be expanded in the future and the cost effectiveness of those additions.

If the proposed work is a continuation of previously completed work, describe the extent to which the continued success of the prior work is dependent upon the proposed work. If the previous work was funded by a State agency, list the project name and year the grant was awarded.

Q15 - Availability of Water

If the proposed project requires water, describe the water requirements (volume and quality) and identify the source(s). Explain the reliability of the water source and describe how the proposed habitat would be influenced by a temporary reduction or interruption of water supply or changes in water quality. Identify the sources of funding for the water supply.

Q16 - Adjacent Property Impacts

Describe how the proposed project might affect adjacent property and landowners. Disclose any known concerns or opposition to the project or land access issues.

Q17 - Sustainability and Climate Change

Describe the resilience of the proposed habitat to changing conditions, such as higher average temperatures, decrease in the surface elevation of the Salton Sea, and increased salinity in the Salton Sea. Indicate the period of time that the proposed habitat would be functional.

Section : Water Quality Improvement Project

Water Quality Improvement Project

Q6 - Project Type

Is your project a Water Quality Improvement type of project? If it is go to question #2 of this section. If not, go to the appropriate project type section to complete your application.

1) ☐ Yes
2) ☐ No

Q7 - Project Goals and Objectives
State the goals and objectives of the proposed project. These should be simple, objective statements about what the proposed project seeks to accomplish over the near and long term. The goals should be measurable and consistent with the Program goals identified in the guidelines. Include a description of performance metrics that could be used to measure the effectiveness in achieving the stated goals and objectives.

Q8 - Proposed Water Quality Improvements

Describe the proposed water quality improvement project, including physical features of the project, the source and quality of the water to be improved, the water quality issue to be addressed (for example, selenium, nutrients), the anticipated level of improvement, the location of any proposed facilities, the anticipated volume of water with improved quality, the anticipated use of improved water, the amounts and disposition of contaminants removed, and other relevant characteristics of the proposed project. Indicate the timeframe for the project to become fully functional.

Q9 - Current Site Conditions

If the project requires the construction or installation of facilities, describe the current conditions at the location(s) where the facilities would be installed. Include information on characteristics such as land use, topography, soils, vegetation, wildlife usage, drainage patterns, contaminants, and any other features pertinent to the proposed project location. If the proposed project involves changes in land use practices in the watershed, describe the characteristics of the area affected. Indicate whether the site is occupied by State- or federally listed species or species of special concern.
Attach a location map and any photos or figures that illustrate the current condition of the site or area on the “Site Map and Photos” section of the application under the tab labeled “General Information and Attachments.”

Q10 - Proposed Approach

Generally describe the approach for implementation of the proposed work. As relevant, include information on construction, water conveyance, planting, and other key features of the proposed work. Indicate whether the proposed techniques have been successfully implemented at the Salton Sea or in a similar environment. Demonstrate that the best available science has been incorporated into the approach.
If relevant, attach design drawings and other graphical information related to the design on the “Design Drawings and Figures” section of the application under the tab labeled “General Information and Attachments.”
Also attach a Work Plan, Budget, and Schedule as described on the “General Information and Attachment” tab of this application.

Q11 - Project Benefits
Describe the anticipated benefits to be provided by the proposed project and explain how the project would further the goals of the Program. Identify the species or habitats that would benefit from the water quality improvement and describe the relative contribution the project would make in supporting the priority fish and wildlife described in the guidelines.

Q12 - Operations and Maintenance (O&M)

Generally describe how the project would be operated and maintained over time. Include a description of periodic maintenance activities that would be required, an estimate of projected costs, and a description of the frequency and timing of activities such as water management, vegetation management, sediment removal, and other O&M activities relevant to the proposed project. Indicate who would perform long-term maintenance and describe how the O&M would be funded. The applicant will be expected to prepare a detailed O&M Plan for the project, which should be included as a task component of the Work Plan and Budget.

Q13 - Monitoring and Adaptive Management

Generally identify the areas of scientific uncertainty associated with the project and describe the plan to adaptively manage the project to help ensure that the project goals and objectives are achieved. Describe the monitoring that would be conducted to measure performance and inform adaptive management adjustments in the future. The applicant will be expected to prepare a detailed Monitoring and Adaptive Management Plan for the project, which should be included as a task component of the Work Plan and Budget. Monitoring reports are to be submitted annually to DFG. Funding for implementation of the first two years of monitoring under the plan can be included in the applicant’s budget. Indicate the funding source for the monitoring and adaptive management beyond the initial two years.

Q14 - Phasing

Indicate whether and how the proposed work might be phased or reduced if the project is funded at a reduced level. Explain how project benefits and total cost of the project would be affected if portions were deferred to later years. Describe the extent to which the proposed project could be expanded in the future and the cost effectiveness of those additions.

If the proposed work is a continuation of previously completed work, describe the extent to which the continued success of the prior work is dependent upon the proposed work. If the previous work was funded by a State agency, list the project name and year the grant was awarded.

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Describe the water requirements (volume and quality) and identify the source(s). Explain the reliability of the water source and describe how the proposed project would be influenced by a temporary reduction or interruption of water supply or changes in water quality.

Q16 - Adjacent Property Impacts

Describe how the proposed project might affect adjacent property and landowners. Disclose any known concerns or opposition to the project or land access issues.

Q17 - Sustainability and Climate Change

Describe the sustainability of the proposed project and its resilience to change.

Section : Research Project

Research Project

Q6 - Project Type

Is your project a Research type of project? If it is go to question #2 of this section. If not, go to the appropriate project type section to complete your application.

1) ☑ Yes
2) □ No

Q7 - Research Goals and Objectives

State the goals and objectives of the proposed research project.

Our goal is to establish proof-of-concept for a novel constructed-wetland water treatment system (CWTS) for the removal of Se, fertilizer nutrients and other contaminants from river water so as to provide a clean water supply for the SCH and other habitat-related projects. The design of the CWTS was developed after a 2.5-year study at UC Berkeley. After successfully testing this design using mesocosms and pilot treatment systems under greenhouse conditions, we now wish to proceed to the next step, which is to test and improve the efficacy of the design under field conditions at the Salton Sea. The specific objectives are: 1) To construct a pilot CWTS consisting of a sedimentation basin and 16 treatment cells at a site adjacent to the Alamo River. The pilot system design and location are described in Attachment 7 and will be built and maintained by the Imperial Irrigation District (IID). 2) To establish proof-of-concept of the proposed CWTS design by determining its efficiency for removing Se, fertilizer nutrients and other pollutants from river water to be obtained from the Alamo River. 3) To maximize the efficiency of the CWTS design in terms of its ability to remove pollutants by determining the minimum wetland residence time for maximum pollutant removal. 4) To determine the most appropriate algal species and algal population density for maximizing the removal of Se from river water through Se volatilization. 5) To determine the changes in pollutant removal efficiencies (i.e., for Se, N, P and S) as the wetland matures over the 3-year experimental period.
6) To determine the extent to which Se ecotoxicity within the CWTS ecosystem can be mitigated by the inclusion of an algal treatment cell. This will be tested by determining the amounts and chemical forms of residual Se that accumulates in the algal-cattail treatment systems with four different algal population densities. The bioavailability (and therefore potential Se ecotoxicity) of the residual Se forms in each case will be determined by speciating the chemical forms of Se in plants, sediments and wildlife using x-ray absorption spectroscopy.

Q8 - Proposed Research

Describe the proposed research, the scientific basis, and the questions that the research would investigate. Include any conceptual models that may help clarify the areas of uncertainty. Attach any relevant conceptual models on the “Design Drawings and Figures” section under the “General Information and Attachments” tab.

The research proposed is to test the concept that a constructed wetland water treatment system (CWTS) can be constructed to provide a low-cost, low-maintenance water treatment system for the cleanup of river water contaminated with Se, fertilizer nutrient and other pollutants. This low-salt clean water supply can then be used to support the proposed species conservation habitat at the Salton Sea. The scientific basis for this approach is as follows. Constructed wetland studies have shown that substantial quantities of Se may be removed from oil refinery wastewater (Hansen et al., 1998) and agricultural drainage water (Gao et al., 2003; Lin and Terry, 2003). Although these early studies show that substantial quantities of Se could be removed from Se contaminated water, their rather primitive design did not permit Se concentrations in the outflow to be less than 5 μg Se/L. In April 2010, we began a series of studies at UC Berkeley to improve the design of the water treatment system. This was achieved using a series of experiments with wetland mesocosms in a greenhouse. By testing a number of treatment options we developed an innovative design using a cattail-planted wetland mesocosm that was able to reduce Se concentrations in the water column from 15 μg Se/L to 0.1 μg Se/L within 72 hours. A second concern with using constructed wetland water treatment systems for Se removal is that, over a number of years, potentially ecotoxic chemical forms of Se may be accumulated within the water treatment ecosystem. In order to mitigate this problem we explored the idea of incorporating an algal treatment cell ahead of the cattail-planted cell to enhance removal of the Se from the ecosystem by volatilization. Algae have a considerable propensity to take up and volatilize Se directly; our research has shown that as much as 50% of the Se may be removed in this way. In addition, as the Se-containing algae flow into the cattail cell, they die and decay yielding still more volatile Se through microbial activity. Although we have obtained evidence in support of these conclusions under laboratory conditions, it is essential that these results are confirmed under field conditions in a pilot wetland at the Salton Sea. Our research proposes to answer the following questions: 1. How efficiently can the pilot CWTS remove Se, fertilizer nutrients and other contaminants from river water obtained from the Alamo River? 2. What is the minimum residence time needed to achieve a given level of efficiency of contaminant removal? 3. What proportion of the water flow entering the CWTS reaches the outflow, i.e., how large are the losses due to evaporation and seepage? A related question is, how large should the treatment facility be in order to generate sufficient clean water to support the species conservation habitat? 4. Which management practices should be applied to enhance contaminant removal efficiency, especially with respect to Se? 5. To what extent can Se accumulation within the wetland ecosystem be mitigated by practices that enhance Se volatilization? A related question is, how much Se, and in what chemical forms, is Se accumulated in various components of the wetland ecosystem, including plants, sediments and wildlife, over time?

Q9 - Relevance to Program Goals
Describe how the proposed research directly relates to the successful creation and maintenance of habitat at the Salton Sea in the near term. Within the context of previous attempts to collect similar information, describe how the proposed research would fill a data gap or provide new information useful to improving existing and future habitat values.

The primary goal of the Salton Sea Financial Assistance Program is to maintain and enhance habitat values for fish, birds and other wildlife, which are threatened by rising salinity levels. The salinity problem will be further aggravated as waters flowing to the Salton Sea are discontinued in accordance with the Quantification Settlement Agreement of 2003. In order to provide usable habitat for fish and wildlife, alternative low-salt clean water supplies are desperately needed, and as soon as possible. The only alternative water supplies available to the Salton Sea come from agricultural irrigation drainage water and local rivers such as the Alamo River and the New River (the Alamo and New Rivers have average salinity concentrations of 2.0 and 2.6 ppt, respectively, C. Holdren, Reclamation, unpublished data). All of these water sources are contaminated with fertilizer nutrients, particularly nitrogen and phosphorus, as well as Se.

Fertilizer nutrient entering the species conservation habitat presents particularly serious problems because it leads to eutrophication and fish death. Piscivorous birds are therefore cutoff from a major food source. The proposed research is designed to produce substantial quantities of clean water using water from local rivers which has been treated to remove Se and fertilizer nutrients. Because the treated effluent water coming from the CWTS is essentially low-saline fresh water, it can be readily mixed with Salton Sea water to help maintain salinity at levels low enough to support a functioning and usable habitat for fish and wildlife. Based on the EIS/EIR draft report (DWR, 2011. Project Operations. Environmental Impact Report for the Salton Sea SCH Project), the SCH ponds would most likely be operated in the range of 20 to 40 parts per thousand (ppt) salinity. Water from the Alamo River (or New River) with salinities of ~2-3 ppt could be blended with water from the Salton Sea with a current salinity of ~53 ppt to produce the desired pond salinity. Blending the river water and seawater in different amounts would allow for a range of salinities to be used in the SCH ponds.

Q10 - Research Methods

Describe the approach and design of the proposed research. Include the initial hypotheses to be tested, anticipated experimental methods, and likely statistical analyses. For research conducted in the field, indicate the locations where work would occur.

Attach maps and other graphical information related to the research on the “Design Drawings and Figures” section of the application under the tab labeled “General Information and Attachments.”

Also, attach a Work Plan, Budget, and Schedule as described on the “General Information and Attachment” tab of this application.

Hypotheses. The main hypothesis to be tested is that using a combination of algal- and cattail-planted treatment cells it will be possible to create a highly efficient water treatment system that: 1) removes Se (and fertilizer nutrient, e.g., N, P and S) from the river water to extremely low levels, and 2) substantially reduces the accumulation of Se in the CWTS ecosystem due to the fact that Se will be volatilized to the atmosphere by algae, microbes and plants. The central and key part of the pilot wetland will consist of 4 separate 2-cell treatment components, each of which will be arranged as shown: | 2-cell treatment component | River water ? sedimentation pond ? | algal cell ? cattail cell | ? outflow to playa The main purpose of the algal treatment cell is to achieve a substantial removal of Se from river water by volatilization to the atmosphere. By
this means we will greatly diminish the accumulation of Se (especially potentially ecotoxic forms of Se) within the CWTS ecosystem. Selenium volatilized to the atmosphere results in a net loss of Se from water, sediments, plants and other wildlife within the local ecosystem. Selenium will be volatilized through direct algal metabolism of absorbed selenate (Terry, et al., 2000). As the Se-bearing algae flow from the algal treatment cell to the cattail treatment cell, more Se will be volatilized through the action of microbes as they metabolize (decompose) the algae at the surface of the cattail sediments. Research overview. The narrative describing the field research plan (including the construction and design, monitoring, location, site characteristics, setup, list of experiments, field sampling methods, water budget calculation, analytical methods, and statistical analyses) are presented in Attachment 7. The map of the location, figures illustrating the CWTS design and other figures illustrating the research plan are presented in Attachment 8. The first step in the field test of the CWTS design is to determine the minimum residence time needed to achieve maximum removal of Se and fertilizer nutrients (e.g., N, P and S) by the cattail-planted wetland: residence times of 3, 6, 9 and 12 days will be tested (Experiment 1). In Experiment 2 the algal treatment cells will be set up with varying algal population densities in order to answer two specific questions: 1) Does the inclusion of an algal treatment cell significantly reduce the amount of Se (especially ecotoxic forms of Se) accumulated in the cattail-treatment cell, and 2) if such a reduction is obtained, what is the quantitative effect of varying algal population density on achieving this Se reduction? In Experiment 3, we will test 4 different algal species with respect to their efficiency of pollutant removal (especially by volatilization). Experiment 4 is concerned with the changes that take place as the cattail treatment cell matures. Previous research has shown that constructed wetlands may become more efficient in removing pollutants as they mature (Zhang et al., 2003). By following the efficiency of Se, N, P and S removal over the three year period we will determine the extent to which wetland maturity affects pollutant removal efficiency. The hypothesis that Se ecotoxicity within the CWTS ecosystem can be mitigated by the inclusion of an algal treatment cell to remove Se through volatilization will be tested by determining the amounts of residual Se that accumulates in the CWTS ecosystem over time in each of the four algal-cattail treatment components. The bioavailability of the residual Se forms will be determined by speciating the chemical forms of Se in plants, sediments and wildlife using x-ray absorption spectroscopy.

Q11 - Timeframe

Indicate how soon after project initiation the proposed research could provide managers with preliminary interpretations of data that may lead to insight into creation and management of habitats.

Year 1: The proposed CWTS will be built in January 2013 by the Imperial Irrigation District collaborator agency (IID) at a 10-acre site near the Alamo River, based on the design provided by UC Berkeley. During the same month, planting will be conducted and the long term monitoring will be initiated for the wetland maturity experiment. Once the cattail and algal population are established during the next four months, we will start the residence time and algal experiments (May 2013). All the experiments and monitoring will continue for the duration of the CWTS research program. Years 2 and 3: The work will be continued in the field and in the laboratory to assess the progress and long-term performance of the CWTS. Adjustments in the design and operation of the CWTS will be made based on the results from the previous year as required.

Q12 - Phasing
Indicate whether and how the proposed work might be phased or reduced if the project is funded at a reduced level. Explain how project benefits and total cost of the project would be affected if portions were deferred to later years.

In order to provide proof-of-concept for this water treatment system, we believe that it will take a full 3-year research program. The first year will be taken in constructing, planting and establishing the CWTS, and in carrying out the first set of monitoring experiments. The second and third years will be needed to properly assess the changes occurring in response to wetland maturity, i.e., changes in pollutant removal efficiency, and in the buildup and speciation of residual Se in the CWTS ecosystem. However, if the project is shortened to 2 years, this would provide useful information as to removal efficiency and Se buildup but would not be sufficient to determine the sustainability of the CWTS over time.

Q13 - Benefits of the Research

Describe the anticipated benefits to be provided by the proposed research and explain how the results would further the goals of the Program. Indicate the species that would ultimately benefit from the work and describe the relative contribution the project could make in supporting the priority fish and wildlife described in the guidelines.

The Salton Sea ecosystem is currently facing two major problems, diminishing water supplies and increasing salinity, both of which will result in loss of habitat for fish and wildlife. To compensate for this loss of habitat along the shores of the Salton Sea, it has been proposed to construct a Species Conservation Habitat (SCH), as mandated by the Salton Sea Restoration Fund (DWR, 2010). If untreated water (e.g., from the Alamo River or New River) is used to supply the SCH, there may well be additional problems of eutrophication and Se ecotoxicity. Both rivers contain fertilizer nutrients and Se, as well as total suspended solids, all of which can damage the delicate Salton Sea ecosystem. The major benefit of this research therefore is that it will facilitate the development of a cost-effective water treatment system for treating river water, thereby providing a low-salt clean water supply to support the SCH. Selenium, a teratogen, is especially problematic to fish and birds because of its biomagnification within the food web. Our research will further the goals of the Program by developing and evaluating a combined algal-cattail treatment system to minimize Se buildup by enhancing Se volatilization to the atmosphere. The effectiveness of this approach will be validated, first, by monitoring the buildup of Se in the CWTS ecosystem over time, and second, by determining the bioavailability and therefore potential Se ecotoxicity using high energy x-ray absorption spectroscopy to speciate Se in sediments, plant and animal tissues. Thus, this research will provide a thorough assessment of the effectiveness of the proposed design in mitigating Se eco-toxicity within the CWTS ecosystem. The main species to be protected by this clean water treatment system include regional endangered species and other species of special concern such as desert pupfish (Cyprinodon macularius), and California brown pelican (Pelecanus occidentalis californicus), migratory birds (Podiceps nigricollis, Calidris mauri), colonial breeding water birds (Gelochelidon nilotica, Rynchops niger), breeding shore birds (Recurvirostra americana, Himantopus mexicanus), and other piscivorous birds that rely on the current fish resources at the Salton Sea (Pelecanus erythrorhynchos, Phalacrocorax auritus).

Section : Adaptive Management Experimentation Project

Adaptive Management Experimentation Project
Q6 - Project Type

Is your project an Adaptive Management Experimentation type of project? If it is go to question #2 of this section. If not, go to the appropriate project type section to complete your application.

1) ☐ Yes
2) ☐ No

Q7 - Adaptive Management Goals

State the goals and objectives of the proposed adaptive management experiment. These should be simple, objective statements about what the proposed work seeks to accomplish over the near and long term. The goals should be measurable and consistent with the Program goals identified in the guidelines. Include a description of performance metrics that would be used to measure the effectiveness in achieving the stated goals and objectives.

Q8 - Proposed Experiment

Describe the proposed adaptive management experiment. Include a description of the habitat or management practices that would be manipulated for the purposes of the experiment and the timeframe over which the experiment would be conducted. Describe the rationale for the proposed experiment, including the scientific basis and any conceptual models that help clarify the areas of uncertainty. Attach any relevant conceptual models on the “Design Drawings and Figures” section under the “General Information and Attachments” tab. Indicate the timeframe for the project to become fully functional.

Q9 - Current Site Conditions and Management

Identify the owners and land managers of the site where the proposed work would be conducted. Describe the current conditions at the site proposed for the experiment, including information on the physical characteristics pertinent to the proposed project. Describe how the site is managed, with particular attention to management actions that may be modified as a result of the experiment. Indicate whether the site is occupied by State- or federally listed species or species of special concern. Attach a location map and any photos or figures that illustrate the current condition of the site on the “Site Map and Photos” section of the application under the tab labeled “General Information and Attachments.”

Q10 - Proposed Approach
Describe the approach for implementation of the proposed work. Include information on the study design, monitoring requirements, and a description of how management would be adapted as a result of project outcomes. Also, describe the extent of any additional activities at the site needed to accommodate the experiment, such as earthwork, installation of water conveyance structures, planting, invasive plant removal, erosion control, and other key actions of the proposed work. Indicate whether the proposed techniques have been successfully implemented at the Salton Sea or in a similar environment.

Attach design drawings and other graphical information related to the experiment on the “Design Drawings and Figures” section of the application under the tab labeled “General Information and Attachments.”

Also attach a Work Plan, Budget, and Schedule as described on the “General Information and Attachment” tab of this application.

Q11 - Project Benefits

Describe the anticipated benefits to be provided by the proposed project and explain how the project would further the goals of the Program.

Q13 - Phasing

Indicate whether and how the proposed work might be phased or reduced if the project is funded at a reduced level. Explain how project benefits and total cost of the project would be affected if portions were deferred to later years.

Q13 - Availability of Water

If the proposed project requires additional water, describe the water requirements (volume and quality) and identify the source(s). Explain the reliability of the water source and describe how the proposed project would be influenced by a temporary reduction or interruption of water supply or changes in water quality.

Q14 - Adjacent Property Impacts

Describe how the proposed project might affect adjacent property and landowners. Disclose any known concerns or opposition to the project or land access issues.

Section : Attachments Section

Attachments Section

A1 - Authorizing Resolution

Attach a scanned copy of a signed resolution or equivalent document from the applicant’s governing board or officer authorizing the submittal of this application.
A2 - Applicant Team Organization: Chart

Attach an organization chart indicating key staff and their roles relative to the proposed work.

A3 - Resumes/CVs

Attach resumes/CVs for the PM/PI and key staff proposed for the project. You can combine all the CVs in one document as long as the individuals are identified.

A3 - Continued

Upload additional CVs and Resumes here if needed.

A4 - Work Plan

Attach a work plan with a task-by-task description of how the proposed work would be conducted and identify the deliverables for each task. The work plan must also identify which costs are being directly funded by the Program.

A4 - Continued

Upload here any additional documents describing the work plan if needed.

A5 - Budget
Attach a budget for the requested funding showing the breakdown of estimated costs of the proposed work by task, including a list of equipment to be purchased as part of the project. The budget should also indicate the total cost of the project and the source of additional funding, if any, including any cash contributions, in-kind services, volunteer effort, maintenance and operation costs, and other grant funding. Please differentiate the grant request from the total project budget and demonstrate how the grant award would be tracked separately. Also, describe the basis for the cost estimates and the methods used to calculate them.

Last Uploaded Attachments: Attachment 6 Budget.pdf

A5 - Continued

Upload any additional documents describing the Budget if needed.

A5 - Continued

Upload any additional documents describing the Budget if needed.

A5 - Continued

Upload any additional documents describing the Budget if needed.

A6 - Schedule

Attach a schedule for completing the proposed work by task, and indicate significant milestones. This can be submitted in Microsoft Word, Excel, or Project file formats.

Last Uploaded Attachments: Attachment 5 Schedule.pdf

A6 - Continued

Upload here any additional documents describing the Schedule if needed.

A6 - Continued

Upload here any additional documents describing the Schedule if needed.

A6 - Continued

Upload here any additional documents describing the Schedule if needed.

A7 - Site Maps and Photos
Attach a location map indicating the proposed project and vicinity, and any photos and diagrams that would help illustrate the current condition of the proposed site. Please include a legal description of the project site, if available.

A7 - Continued

Upload any supplemental maps or photos related to the project if needed.

A7 - Continued

Upload any supplemental maps or photos related to the project if needed.

A7 - Continued

Upload any maps or photos related to the project if needed.

A8 - Design Drawings and Figures

Attach design drawings that depict the proposed habitat creation or enhancement as well as any diagrams or figures that would help illustrate project features and assist in the review of the proposal.

Last Uploaded Attachments: Attachment 7 Field research plan.pdf,Attach 8 Site map, design figures and tables.pdf,Attachment 11 References.pdf

A8 - Continued

Upload here any supplemental drawings and figures related to the project if needed.

A8 - Continued

Upload here any supplemental drawings and figures related to the project if needed.

A8 - Continued

Upload here any supplemental drawings and figures related to the project if needed.

A9 - Letters of Support

Attach any letters or other evidence from local entities indicating support for the proposed project.

Last Uploaded Attachments: Attachment 9 Letter of support IID.pdf,Attachment 9 Letter of support Prof Sposito.pdf,Attachment 9 Letter of Support Dean CNR.pdf

A9 - Continued
Upload any letters of support you may have received.

A10 - Operation and Maintenance Plan

Upload your Operation and Maintenance plan if needed.

Last Uploaded Attachments: Attachment 10 Operation and Maintenance Plan.pdf