CALIFORNIA BAY-DELTA AUTHORITY

650 Capitol Mall, 5th Floor
Sacramento, CA 95814
916.445.5511 FAX 916.445.7297
http://calwater.ca.gov

CONSIDERATION OF A RESOLUTION AUTHORIZING THE DIRECTOR, OR DESIGNEE, TO SIGN AN INTERAGENCY AGREEMENT WITH SAN JOSE STATE UNIVERSITY FOUNDATION FOR MERCURY RESEARCH AND TECHNICAL SERVICES
Agenda Item: 10

Meeting Date: 08-14-03

Summary: This resolution would authorize the Director, or designee, to sign an interagency agreement with San Jose State University Foundation, to further the ecosystem water quality and drinking water quality objectives in the Ecosystem Restoration Program related to mercury contamination. This agreement would provide research and technical services to determine the sources of mercury in the Bay-Delta watershed, and what environmental factors affect mercury transport and transformation processes as it moves through the watershed and into the foodweb.

Recommended Action: Adopt Resolution 03-08-13.

Staff Recommendation: Staff recommends the Authority adopt the attached resolution, authorizing the Director to enter into this interagency agreement with San Jose State University Foundation for mercury related research and technical work.

Background

The CALFED Programmatic Record of Decision and the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act (Proposition 13) propose actions that include reduction of sources of mercury in the Bay-Delta watershed. San Jose State University submitted a proposal for grant funding through the Ecosystem Restoration Program's 2002 Proposal Solicitation Process to investigate sources of mercury in the watershed and how they affect mercury bioaccumulation in biota. The project was selected to receive grant funds from both Proposition 204 and Proposition 13. This proposed interagency agreement would provide the Proposition 13 funds to support a portion of the project to investigate sources and loads of mercury and their relative importance to water quality in the Bay-Delta.

Fiscal Information

Funding Source: DWR Proposition 13 – these funds will move to the Authority pursuant to a budget change proposal
Term of Contract: July 1, 2003, through June 30, 2006
Amount: $1,213,121.00

List of Attachments

Proposed scope of work

Contact

Name: Dan Castleberry **Phone:** (916) 445-0769

CALIFORNIA BAY-DELTA AUTHORITY
RESOLUTION NO. 03-08-13

CONSIDERATION OF A RESOLUTION AUTHORIZING THE DIRECTOR, OR DESIGNEE, TO SIGN AN INTERAGENCY AGREEMENT WITH SAN JOSE STATE UNIVERSITY FOUNDATION FOR MERCURY RESEARCH AND TECHNICAL SERVICES

WHEREAS, the CALFED Programmatic Record of Decision and the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act (Prop 13) propose actions that include reduction of sources of mercury in the Bay-Delta watershed; and

WHEREAS, the CALFED Ecosystem Restoration Program issued a competitive grant solicitation in 2002 to seek proposals for mercury-related research and action; and

WHEREAS, San Jose State University Foundation submitted a proposal entitled "Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries – An Integrated Mass Balance Approach"; and

WHEREAS, San Jose State University Foundation's proposal was recommended for funding by the Selection Panel for the Ecosystem Restoration Program, with a portion of the funding recommended to be from the Resources Agency's Proposition 204 funds, and a portion of the funding recommended to be from Proposition 13 funds previously held by the Department of Water Resources; and

WHEREAS, the Proposition 13 funds previously held by the Department of Water Resources are anticipated to be transferred to the Authority's budget effective with the 2003/2004 budget; and

WHEREAS, the Resources Agency has provided the grant of Proposition 204 funds to San Jose State University Foundation through an interagency agreement for a portion of the proposal entitled Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries – An Integrated Mass Balance Approach; and

WHEREAS, a complementary interagency agreement with the Authority for the remainder of the funds will allow San Jose State University Foundation to full implement its proposal for mercury related research and action;

NOW, THEREFORE, BE IT RESOLVED that the Authority authorizes the Director, or his designee, to execute an interagency agreement with San Jose State University Foundation, for the purposes generally described in the attached scope of work, for an amount not to exceed $1,213,121.00 in Proposition 13 funds, subject to appropriation of adequate funds.

CERTIFICATION

The undersigned Assistant to the California Bay-Delta Authority does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the California Bay-Delta Authority held on August 14, 2003.

Dated:

Heidi Rooks
Assistant to the California Bay-Delta Authority

Attachment 1
Mercury Research and Technical Services
Proposed Scope of Work

I. PROJECT OFFICIALS

The Project Representatives during the term of this agreement shall be:

California Bay-Delta Authority **Ecosystem Restoration Program (ERP)**
Name: Donna Podger, Contract Manager
Address: 650 Capitol Mall, 5th Floor Sacramento, CA 95814
Phone: (916) 445-5269

II. PURPOSE OF PROJECT

The purpose of this contract is to provide an integrated research project on sources and loads of mercury in the Bay Delta watershed, and the transport, cycling and transformation that occur to mercury and monomethylmercury within the watershed. This research project will evaluate mercury sources and sinks and biogeochemical cycling using a mass balance approach.

There is widespread mercury contamination in fish, sediment and water in the Central Valley and Bay-Delta Estuary. This mercury poses a human health risk principally through the consumption of mercury-contaminated fish. Health advisories and interim health advisories have been posted in the Bay-Delta Estuary recommending no consumption of large striped bass and limited consumption of other sport fish. Elevated concentrations of mercury in fish tissue may also represent a hazard to piscivorous wildlife. Species most at risk are fish-eating birds and mammals. Mercury contamination in aquatic organisms results from the conversion of inorganic mercury (Hg) to monomethyl mercury (MMHg), principally by sulfate-reducing bacteria in surficial sediments. A recent study by the U.S. Geological Survey in twenty basins across the U.S. demonstrated a strong positive correlation between aqueous MMHg concentrations and fish tissue levels (personal communication, Brumbaugh et al.). Therefore, an understanding of the sources and sinks of aqueous Hg and MMHg is essential both for the development of control programs to reduce fish tissue levels and also to ensure that California Bay-Delta Authority wetland restoration efforts do not exacerbate an already serious human and wildlife health problem.

III. PROJECT FUNDING SOURCE – PROPOSITION 204 AND PROPOSITION 13

The proposal for this project "Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries – An Integrated Mass Balance Assessment Approach" was submitted in October 2001 for the CALFED Ecosystem

Restoration Program 2002 Proposal Solicitation Process (PSP). After extensive review, the proposal was rated as "fund as is" by the final 2002 PSP Selection Panel in Spring of 2002, and approved for funding by the Resources Agency.

The Resources Agency will fund this CBDA Ecosystem Restoration Program project using two funding sources for a project budget total. Overall combined total for the entire project shall not exceed $3,881,212.00.

IV. GENERAL STATEMENT OF WORK TO BE PERFORMED

Task 1 Project Management and Administration

The Contractor shall provide all technical and administrative services associated with performing and completing the work for this project.

The Contractor shall be responsible for the performance of the work as set forth in this agreement as well as for the preparation of products and a final report as specified in this Exhibit A. The Project Director shall promptly notify the Contract Manager of events or proposed changes that could affect the scope, budget, or schedule of work performed under this agreement.

The Contractor shall provide all quarterly progress reports, invoices, and scheduled deliverables as indicated in Exhibit A – Attachment 2 – Detailed List of Deliverables.

Subtask 1.1 Project Management (Required Task)

The Contractor shall provide all technical and administrative services associated with performing and completing the work for this project. Technical and administrative tasks shall include: project management, budgeting, scheduling, coordination, crew supervision, report preparation, contract management, invoicing, equipment maintenance and data collection, storage and analysis, subcontract management, and all other tasks that may be necessary to complete the scope of work specified in this agreement.

The work performed in this subtask also includes the preparation and submission of Quarterly Progress Reports to the CBDA's contract manager; the planning and conducting of quarterly status meetings with all project investigators to review progress and issues from the previous quarter; the preparation and submission of the project Final Report; and the preparation and submission of deliverable products as specified. The Final Report must include a chapter summarizing and integrating the conclusions reached for each of the separate research projects conducted for the mercury mass balance for the Bay-Delta.

Subtask 1.2 Quarterly Progress Reports
Prepare and submit written quarterly progress reports (see Exhibit A – Attachment 3 – Sample Quarterly Report Format) to CBDA's Contract Manager. The progress reports shall detail work accomplished, discuss any problems encountered, and recommend potential solutions to those problems; detail costs incurred during the subject quarter, and document delivery of any intermediate work products. A brief outline of upcoming work scheduled for the subsequent quarter should also be provided. Progress reports

must be submitted by the 10th day of the month following each calendar quarter (April, July, October, January) throughout the duration of the project.

The description of activities and accomplishments of each task during the quarter shall be in sufficient detail to provide a basis for payment of invoices and shall be translated into percent of task completed for the purposes of calculating invoice amounts.

Subtask 1.3 Subcontractor Selection
Award subcontracts, as necessary, to qualified consultants or other agencies. The subcontractors shall be selected by a process that complies with applicable State and Federal regulations. Prepare a legally enforceable agreement between the contractor and the selected subcontractors. The agreement shall describe the scope of work and the products expected from the subcontractors. Submit draft contract documents to the Contract Manager for review and approval prior to execution. Document steps taken in soliciting and awarding the subcontract and submit to Contract Manager for review. In the quarterly progress report, document all subcontractor activities, deliverables completed, progress, issues and proposed resolutions.

Subtask 1.4 Data Management
Prepare and submit all water quality-related data generated by the project to the Contract Manager for input into CBDA's data system. Data formats and report guidance for CBDA's data system shall be provided by the Contract Manager. Data shall be submitted to the Contract Manager on computer diskettes or on forms provided by the Contract Manager. The Contractor shall be responsible for verifying the quality of the data.

Subtask 1.5 Quality Assurance
Many of the analytical and field sampling procedures to be used for this project were described in detail as part of a Quality Assurance Project Plan (QAPP) prepared as part of the Contractor's previous CALFED project. The QAPP is available for download and review from our Web site: http://loer.tamug.tamu.edu/calfed/QA.htm. The QAPP will be reviewed and updated, as necessary, prior to any field or analytical work.

Task 2 Mass Loading, Riverine Characterization and Export Studies

The previous CALFED sponsored Hg studies have demonstrated the importance of river inputs in controlling Hg loads and aqueous and biotic concentrations in the Bay-Delta estuary. Multi-year loading studies are critical for understanding Hg processes and cycling in the system and for developing control programs to minimize the Hg

hazard for people and wildlife. This study will provide funding to continue the loading studies in the Sacramento and San Joaquin watersheds and Bay-Delta Estuary for two additional years. The work will be closely coordinated with the much more limited sampling presently being conducted by the Sacramento Watershed Program.

Subtask 2.1 Determine Mass loading estimates for Hg and MMHg into, and freshwater export from, the Delta

The approach will be similar to that employed in the previous CALFED study. Raw and filtered aqueous total and MMHg concentrations will be determined monthly at all the major inputs to the Bay-Delta (Sacramento, San Joaquin, and Mokelumne Rivers and Prospect Slough in the Yolo Bypass) and at the major export sites (State and Federal pumps and Chipps Island to estimate exports to San Francisco Bay). These measurements will be coupled with flow estimates to calculate Hg loads and sinks (kilograms Hg/month).

Subtask 2.2 Characterize tributary and regional input sources of MMHg and Hg in the Sacramento and San Joaquin Basins.

In a similar fashion, monthly river flow and Hg concentration data will be collected at key locations down the Sacramento and San Joaquin Rivers and from all the major tributary inputs. This will necessitate monitoring about 26 sites monthly in the two basins. The primary goal of the river monitoring will be to calculate mass balance estimates for raw and filtered total and MMHg for each river section. This information will be used to determine river reaches responsible for the major sources and sinks of Hg.

Subtask 2.3 Conduct sub-watershed studies of tributaries or source regions to refine region of sources of MMHg and Hg within a watershed.

The findings in Task 2.2 will be followed with detailed studies on tributary inputs along key river reaches to ascertain sub watersheds responsible for the majority of the load. Once these sub watersheds have been identified, studies will follow in each tributary to identify actual sources. Flow information may or may not be available for the key sub watersheds, but all the flow data available will be used to estimate loads. When unavailable, flows will be estimated with hand-held flow meters and measurements of stream cross section.

It is difficult to estimate how many sub watersheds will necessitate detailed investigative follow-up. Provisionally, funds are provided for sampling about 10 sites monthly. Harley, Sulfur and Davis Creeks have been identified as major sources of Hg to both Cache Creek and the Bay-Delta Estuary. A U.S. Geological Survey gauging site has been constructed on each creek. However, only one year of source

loading information has been obtained for each drainage. Mine remediation efforts are being planned based solely upon this limited information. Contractor will continue to sample Hg discharges to determine background export rates (about 125 samples over a 2 year time frame). Funding is also provided to maintain the three gauging sites. The resulting new background information will be critical in evaluating the effectiveness

of subsequent Hg control efforts. In order to provide more intensive sampling during periods of critical hydrographic events and to gather critical data; some monthly sampling effort may be shifted to other time periods.

Task 3 Atmospheric Mercury Deposition Studies

This study includes funding to set up a series of three atmospheric deposition monitoring stations in the Bay-Delta watershed to estimate the wet deposition of total Hg and also MMHg. Sites will be chosen to characterize input into the coastal mountain range focusing on the Cache Creek watershed, the central Delta region, and the Sierras, focusing on the Cosumnes watershed. Sampling at all sites will be conducted on a bi-weekly basis for approximately a 28-30 month period. Either an Aerochemetrics or a MIC-B wet-dry deposition collector, modified for monitoring Hg, will be used for sample collection. These samplers have been used successfully to monitor atmospheric deposition (Landis and Keeler, 1997; Landing et al., 1998). Preliminary investigations will be conducted to access the importance of the dry deposition flux of Hg by conducting measurements of reactive gaseous mercury (RGM). Initially, RGM measurements will be obtained using approaches developed during the FAMS project (Guentzel et al., 2001). If RGM appears a significant source, the instrumentation recently developed and made available by Tekran, Inc. (see: http://www.tekran.com/access/1130.html) will be acquired or borrowed for determining RGM simultaneously with total gaseous mercury (TGM) in the atmosphere.
reports and presentations for peer review, and a final summary report for Task 3.

Task 4 Delta Wide Monitoring and Characterization Program

Subtask 4.1 Determine Hg and MMHg in surface sediments of different Delta ecosystems (i.e. habitat-based).

In previous studies, increases in MMHg in sediments occurred at some stations during spring and summer, and additional years of seasonal sampling will allow confirmation of these trends. Four sites will be sampled monthly for 30 months, with bi-monthly sampling during late spring and summer of each sampling year. If a recurring elevation of MMHg is observed in the summer, ancillary data will be used to identify environmental conditions leading to summer increases of MMHg. After examination of data collected in year one, an adaptive strategy will be used to adjust sampling and ancillary measurements for the next sampling year, as necessary to identify environmental conditions driving the summer increase of MMHg.

In order to determine how MMHg distribution in sediments relates to habitat type, approximately 28 sites will be sampled twice each year during the three-year term of this project. The chosen sampling locations will be representative of the broad range of habitat types found in the Delta that are incorporated into the National Wetlands Inventory Arc View GIS layers, and will also be located at the sites selected for the other tasks in this proposal, as well as sites from the fish bioaccumulation studies.

The goal is to accurately map the spatial distribution of Hg in the Delta. The sampling is designed to allow comparisons to be made between distinctly different hydrologic seasons (high and low flow), as well as possible changes caused by wet and dry year hydrology. Data will be continually evaluated over the three-year project, and adaptive strategies will be used to adjust sampling as needed to better address the hypotheses. As a result of this project, the foundation for long-term monitoring of the Delta for Hg will be established by this study. This data will be invaluable information for future remediation projects concerned with lowering MMHg levels in fish.

Samples will be stored, processed, and analyzed using non-contaminating techniques, following protocols established for the previous CALFED Mercury Project. The following ancillary measurements and samples will be taken at each station: temperature, conductivity, water depth, water flow rate, turbidity, chlorophyll, nutrients, oxygen, grain size, and total organic carbon. Each sampling station will be described and classified as a habitat type, based on dominant landscape feature.

Subtask 4.2. Benthic Flux Chamber Studies

This study will focus on investigating those areas which are of special importance to future California Bay-Delta Program restoration efforts, including Yolo Bypass, Suisun Marsh and the Cosumnes River. Preliminary evidence, collected during May 2001, suggests that marsh sites are habitats of elevated MMHg fluxes compared to open water sites. MMHg concentrations in sediments in marsh habitats in Franks Track are approximately five-fold higher than in open water areas, and the marsh site had approximately 50% higher flux than the open water site.

This study will focus much more effort on wetlands and marsh area. This task includes 6 field efforts spread out seasonally over approximately a 24-month period with monitoring at 4-6 sites. Field site locations will be integrated with the wetlands studies described in Task 5.3. Benthic flux chamber deployments and sampling are currently conducted manually using SCUBA divers, which is very labor intensive and inefficient. To significantly improve sampling capability, sample collection will be automated so that unattended sampling can be conducted. This will allow for much greater sampling interval flexibility (e.g., 24 hour and light/dark studies) and also will permit multiple chamber deployments at different sites. This will significantly increasing the information obtained during a given field effort.

Task 5 Process Oriented Studies

A series of process-oriented studies are included in this research project to identify links between Hg and methylmercury production and destruction and to derive environmental rate dependencies with respect to major biogeochemical processes and constituent concentrations.

Subtask 5.1 Monomethyl Mercury Photo Demethylation Studies

A recent study in the Experimental Lakes Area (ELA) of northwestern Ontario, Canada observed that MMHg in the water column can undergo destruction through a photodegredation process. If photodemethylation of MMHg is occurring in the Delta, this process could easily be the mechanism for the loss of MMHg that we have hypothesized occurs within the Delta as water flows from the Sacramento River to the export pumps in the southern portion of the Delta. To investigate the possibility that photodemethylation is the mechanism responsible for loss of MMHg in the Delta, this study will include bottle incubation experiments during different seasons of the year at the sites where other process oriented tasks and intensive studies are being conducted. This information will be assessed using the mass balance geochemical framework described previously.

In addition, the MMHg rate loss constants derived from this study to will be compared to:

1) The non-conservative loss quantified from the hydrodynamic model efforts described in Task 4; and,
2) The air-water exchange loss of elemental Hg proposed in Task 5.4.

The combination of these two comparisons will provide constraints on the relative importance of photodemethylation as a MMHg loss mechanism in the Delta. These studies will be conducted in tight coordination with the air-water exchange studies of dissolved gaseous Hg described in Task 5.4.

Task 5.2 Delta Transects and Cross Channel Studies

Work conducted on the previous CALFED Mercury Project suggests that there is an internal sink for MMHg in the Delta. The objective of this task is to thoroughly document the existence of the sink and relate it to hydrologic, chemical, and biological parameters. During low flow regimes in 2000, the concentration of MMHg imported into the Delta (Greens landing data) is always higher than the exports, and recent data indicates the same pattern developed during summer 2001. The concentrations of MMHg represent a balance between sources and sinks that are likely sensitive to the hydrodynamics and water residence times in the system. Therefore, this study includes analysis of hydraulic transport.

The contractor will modify the DSM2 DWR particle tracking model to allow for export, atmospheric exchange, diffusion, particle settling, bioaccumulation, and other processes to be quantified as part of this study. Other models will also be evaluated and used if found to be more useful. The contractor will collaborate with John Burau (USGS) in order to obtain an accurate hydrology mass balance in the target areas where we conduct transects.

Preliminary data from the previous CALFED Mercury Project revealed stations located in the South Mokelumne River Sloughs had significantly higher concentrations of MMHg in May, 2001 than when initially surveyed in October, 1999.

Coincidentally, the Delta Cross Channel was closed in May, 2001. The South Mokelumne River Sloughs are effectively cut off from influences of the Sacramento River by the closing of the Delta Cross Channel. While the Cutoff is closed, the Delta part of the Mokelumne is poorly flushed, providing opportunity for pollutants to accumulate in sediments and water. The existing data, although very sparse, is enough to initiate further investigation into the possible influence of closing the Cross Channel on methylmercury accumulation in sediments of the Northeast Delta. Samples will be collected from locations around the Cross Channel Cutoff immediately before the Cutoff is closed, a few weeks after it is closed, and again a few weeks after it is opened. Data generated from this study will be used to determine if additional investigations are warranted.

Subtask 5.3 Wetland Mass Loading and Sediment Biogeochemistry Studies

The production and bioaccumulation of MMHg in aquatic environments varies widely. Wetlands are often considered to be regions of high MMHg production potential, and there is concern that the Bay-Delta Program Ecosystem Restoration efforts could raise levels of MMHg in the Delta if wetlands are created. Although MMHg production has been associated with wetlands in other areas, it is not known on a quantitative basis how much MMHg in the Delta is created by wetlands, and which types of wetlands create the most MMHg. The wetland loading studies (Task 5.3(a)) will attempt to provide this information. The biogeochemical studies (Task 5.3(b)) will attempt to correlate MMHg in both sediment pore water and sediments to major biogeochemical features occurring in the sediments, to see if a causal link can be established which influences MMHg concentrations.

Subtask 5.3(a) MMHg Loading Studies in Delta Wetlands.

The objective of this task is to determine loadings of MMHg from different types of habitats (salt marsh, fresh water tule marsh, ponds with tules, and the Cache Creek Catchment Basin), and to compare the loadings from these wetlands to loadings from Delta tributaries, atmospheric deposition, and Delta sediment. Using this approach, all the sources of MMHg can be put into perspective so their relative importance can be assessed. Wetland MMHg loading studies and sediment biogeochemistry studies will be conducted at many of the same sites where intensive studies will occur for the other

project tasks. In addition, this work will be closely integrated with the sampling plan proposed for surface sediments in Task 4.1.

The wetland loading studies will use an approach that determines the net mass export/import of MMHg, and will be the difference between what goes in and what comes out of the wetlands. The previous CALFED Mercury Project has completed one study at a tidally-influenced marsh near Frank's Tract using this method; and, another study in a non-tidally influenced area in Cache Creek and the Yolo Bypass area. In both studies, loadings were determined successfully. This technique has also been used successfully in the Experimental Lake area in Canada (Rudd 1995). The loadings estimates will be expressed as mass of MMHg exported per acre, which can then be scaled up to a watershed basis by multiplying loadings by the total amount of

acres per wetland type in the watershed. Fresh water marsh habitats to be studied include sites at Sherman Island, one in the Central Delta near Franks Tract, and one in the Yolo Bypass. Salt-water habitat sites will be selected from Suisun Marsh and the North San Pablo Bay. Freshwater ponds with tule habitats include two sites in the Yolo Bypass Wildlife area and one site yet to be determined in the Delta. Three replicate wetland sites from saltwater marshes, freshwater marshes, and tule ponds will be studied enabling a statistical comparison among types. Loadings will be determined from each site three times per year during the summer for at least two years. In addition, two sites will be studied intensively 9 times per year for two years. Ancillary water column measurements will be made at each site, and include: total suspended solids, chlorophyll- a, temperature, conductivity (or salinity), depth, dissolved oxygen, and sulfate. Sediments will be analyzed for organic carbon, MMHg, and total Hg at each of these sites. Correlation analysis between these measurements and MMHg production will be conducted to identify potential controlling factors of MMHg production.

Subtask 5.3(b) Sediment Biogeochemistry Studies in Delta Wetlands

The primary site of MMHg production within an aquatic ecosystem is often found to occur in near-surface anoxic sediments mediated by sulfate-reducing bacteria (Compeau and Bartha, 1985; Gilmour et al., 1998). Hence, there are a number of environmental variables, characteristics or conditions that could influence the net production of MMHg and its ultimate release into the water column. This task will directly address a number of the hypotheses previously outlined. These include the contention that within the Delta, wetland, and marsh regions are major sites of MMHg production and that MMHg production in the Delta follows seasonal cycles which vary geographically, possibly due to habitat type. The biogeochemical studies will seek to relate MMHg cocentrations in both sediment pore water and sediments to major biogeochemical features occurring in the sediments to see if a causal link can be established which influences MMHg concentrations. These studies will be conducted on a subset of those sites from the wetlands loading studies (Task 5.3(a).

Specifically, this study will examine the depth distribution of MMHg in porewater and sediments relative to other potentially important controlling parameters such as oxygen, sulfate/sulfide, DOC and OC content, Fe and Mn. High resolution near-surface profiles of oxygen, sulfide, and other parameters in interstitial pore waters will be obtained using an in situ microelectrode profiler system from Unisense (http://www.unisense.com/products/products.html) (Gunderson and Jorgensen, 1990, 1991, Gunderson et al., 1992). Depth profiles of MMHg, total Hg and selected other trace elements (e.g., Mn and Fe) will be obtained using either whole-core squeezing techniques (Gill, et al., 1999) or by extrusion of intact cores under the protection of an anoxic environment in a glove bag. Pore water will be isolated using centrifugation. Determination of trace elements will be conducted using ICP-MS techniques developed at Texas A&M University at Galveston (Warnken et al, 2000).

Subtask 5.4 Conduct Air-Water Exchange Studies of Dissolved Gaseous Mercury

The formation of volatile Hg species, particularly elemental Hg, in surface waters, and evasion to the atmosphere is an important component of the cycling of Hg in aquatic systems. This study will conduct measurements of dissolved gaseous mercury (DGM) with a goal of providing quantitative information on the air-water transfer of volatile Hg species for mass balance modeling purposes. These measurements will be conducted using two approaches:

(1) Bottle incubation studies such as those described by Amyot et al (1997a, b); and,
(2) Build and utilize a flux chamber, similar to that described by Carpi and Lindberg (1998) for the determination of soil Hg flux.

The latter approach will be used to determine whether air-water evasion flux of DGM at sites with aquatic vegetation have enhanced fluxes compared to open water sites. Measurements will be conducted during the 6 intensive field efforts, which span different seasons and habitats. These studies will be conducted in close coordination with the Hg photodemethylation studies described in Task 5.1.

Task 6 Integration of GIS into Program

Task 6 includes the integration of GIS approaches into the previous and new projects. The Hg data from this study will be overlaid on the National Wetlands Inventory ARCVIEW layers to estimate the area of MMHg in sediments in different types of habitats in the Delta. To determine the amount of area in the Delta for each habitat type existing maps or aerial photographs will be geo-referenced in an Arc View GIS program. The types of habitats include open water, intertidal mud, tidal salt, seasonal wetlands, farmed wetlands, riparian wetlands, salt ponds, and lake ponds. The different habitats will be delineated and the amount of area for each habitat will be calculated. The final product will be a GIS file with the habitats delineated and a spreadsheet showing the amount of area each habitat occupies. With these calculated areas, we will be able to scale up our limited sampling to obtain projections of the amount of methyl

Hg, total Hg, and fluxes out of the sediment for each of these habitat types. This study will be able to statistically relate the MMHg concentrations in sediments to the flux of MMHg from sediments; thereby, enabling the use of this GIS approach to estimate the amount of MMHg released from sediments in the types of habitats listed above.

B. Performance Measures

This study is a basic scientific research project. Therefore, it is typical to evaluate the performance of a research project or a researcher's findings through generally accepted scientific performance criteria. Such methods of evaluation include: external scientific peer review; annual presentation; publication and dissemination of interim and final reports through the website and highly quality scientific journals. During these scientific peer reviews the following essential elements must be met:

- Meet data quality objectives for chemical analysis
- Field sampling completed on time and within the outlined timeline
- Complete annual presentation of data and participate in an annual external peer review
- Publish interim and final project reports and disseminate information on a project web site
- Seek publication of research results in several papers in high quality peer-reviewed scientific journals

C. Data Handling and Storage

All data will be summarized in a spreadsheet format (e.g. Excel) in a manner acceptable for posting to the IEP web page. Where feasible, data will be stored in an ARCVIEW compatible database. Annual reports will be prepared for scientific peer review. All of these data sources will be maintained by project Principal Investigator's (PI) and made available for public viewing and download on the study web site (http://loer.tamug.tamu.edu/calfed). All of these data sources will also be submitted to the CBDA contract manager with formats and within the timelines described in Exhibit A – Attachment 2 – Detailed List of Deliverables.

D. Expected Products/Outcomes

A major product of this work will be the development of a quantitative geochemical mass balance model which describes the major sources, sinks, and cycling of total Hg and MMHg in the Bay-Delta and its watershed. This model will be based on the conceptual model of Hg cycling in the Bay Delta ecosystem presented in the project proposal. Other products and outcomes of this project include the list of deliverables described in Section IV Sub-section F – Work Schedule and Exhibit A - Attachment 2 – Detailed List of Deliverables.

E. Scientific Review and Quality Assurance.

The Contractor and subcontractors will participate in annual scientific review by a panel of outside mercury experts. The Contractor and subcontractors will participate in the annual scientific review by providing annual written summary reports, and if applicable, a presentation at an annual review workshop. The organization and administration of the annual review workshop will be conducted by the Ecosystem Restoration Program and Science Program.

If applicable, the Contractor and subcontractors will participate in an external Quality Assurance/ Quality Control (QA/QC) Program directed by CBDA for all mercury research projects. The external QA/QC may require split samples to be sent to an independent reference laboratory and annual inter-calibrations. The funds for the external QA/QC analysis are not included in this contract, but may be added by amendment when the external QA/QC program is developed.

F. Term/Work Schedule

The term of this agreement is 3 years, commencing on July 1, 2003. Field sampling will begin in the summer of 2003 and continue through the end of February 2006 (~30 months). A final report will be produced on or before June 30, 2006. The project will participate in external peer review on an annual basis if the review is organized and funded by CBDA. A detailed timeline showing the various components of the project are provided in Exhibit A – Attachment 1 – Project Timeline/Schedule.

	Deliverable	Estimated Completion Dates
1	**Project Management and Administration** a) Quality Assurance Project Plan b) Quarterly Progress Reports c) Quarterly Invoices d) Annual Reports e) Presentations at Scientific Meetings f) Participation in Workshops & Seminars g) Seek publication in scientific journals h) Dissemination of information & research results on websites i) Draft Project Report j) Final Project Report	a) September 1, 2003 b) Quarterly throughout the term of the contract c) Quarterly through out the term of the contract d) September 2004, 2005 e) June 30, 2006 f) June 30, 2006 g) June 30, 2004, 2005, 2006 h) March, 2006 i) June 20, 2006
2	**Mass Loading, Riverine Characterization, & Export Studies** a) Annual Reports b) Presentations at Scientific Meetings c) Participation in Workshops & Seminars d) Final Summary Report	a) January 2004, 2005, 2006 b) June 30, 2006 c) June 30, 2006 d) June 30, 2006
3	**Atmospheric Mercury Deposition Studies** a) Annual Reports b) Presentations at Scientific Meetings c) Participation in Workshops & Seminars d) Final Summary Report	a) January 2004,2005, 2006 b) March 31, 2006 c) March 31, 2006 d) March 31, 2006
4	**Delta Wide Monitoring & Characterization Program** a) Annual Reports b) Presentations at Scientific Meetings c) Participation in Workshops & Seminars d) Final Summary Report	a) January 2004, 2005, 2006 b) March 31, 2006 c) March 31, 2006 d) March 31, 2006
5	**Process Oriented Studies** a) Annual Reports b) Presentations at Scientific Meetings c) Participation in Workshops & Seminars d) Final Summary Report	a) January 2004, 2005, 2006 b) March 31, 2006 c) March 31, 2006 d) March 31, 2006
6	**Intergation of GIS into Program**	

	Deliverable	**Estimated Completion Dates**
	a) Input GIS file of habitats in Delta b) Create & complete spreadsheet calculations of Hg Fluxes based on habitat type	a) March 31, 2006 b) March 31, 2006