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VIA E-Mail

January 20, 1998

Judy Heath
CALFED Bay-Delta Program
Water Quality Technical Group
1416 Ninth Street; Suite 1148
Sacramento, CA 95814

Dear Judy:

Following up on your request to review the report by Gail Louis of US EPA Region 9 devoted to "Mercury Action Example," I wish to provide the following comments.

Ms. Louis states,

"This action is intended to provide an example of how we believe the action strategies comprising CALFED's Water Quality Common Program could be fleshed out in greater detail to provide the reader with both a better context within which to consider the action (including a problem statement and discussion of existing programs) and greater specificity regarding the intended action strategy itself."

It is stated that this "mercury action" represents work in progress.

Background

As background to these comments, I have been involved in water quality evaluation and management from an aquatic chemistry, public health and aquatic toxicology perspective for over 35 years. My work has included 30 years of university graduate-level teaching and research during which I had about 100 graduate students do their master's theses or Phd dissertations on the aqueous environmental chemistry of a constituent relative to developing technically valid, cost-effective control programs for the constituents in aquatic systems. Mercury has been one the constituents that I have worked on periodically over this period. One of the issues of particular concern to me is the potential significance of various forms of mercury as a source of mercury that leads to excessive bioaccumulation. Over the last half a dozen years, I have become interested in the excessive mercury bioaccumulation issues in the Sacramento - San Joaquin River Delta and San Francisco

Bay. Upon learning of Chris Foe's work on Cache Creek, I have become increasingly involved with Chris, Bill Croyle and others who are concerned with the Cache Creek mercury problem. I have attended a number of meetings organized by the Central Valley Regional Water Quality Control Board staff devoted to these issues. Further, I am an active participant in the Cache Creek mercury work group.

Last summer I submitted a proposal to CALFED for support that would have enabled me to provide my expertise and experience to develop coordinated technical guidance on how to develop the technical aspects of regulating the mercury associated with Cache Creek high flows. While the Cache Creek mercury group supported the activities that I proposed to conduct on behalf of the group through CALFED, the CALFED review process did not enable this proposal to be sufficiently ranked to make it through the first level of review. This is not surprising since it was mechanically reviewed as though it were a research proposal rather than a proposal to provide me with sufficient funds to serve as a facilitator to help CALFED, the Cache Creek Mercury Group and all stakeholders to develop a technically valid, cost-effective approach for managing the excessive bioaccumulation of mercury that occurs within the Delta and upper San Francisco Bay. A key component of the proposal was funding to provide independent peer review of the various research projects and CALFED activities on mercury control. This peer review was singled out as by the Cache Creek Mercury Group as a high priority for activities.

A copy of that proposal is appended to these comments since it summarizes key information on the mercury problem that I have found needs to be considered in formulating the CALFED mercury management program.

Specific Comments

Page 1, second paragraph, states that high levels of mercury in fish and recreational fish have rendered certain fish inedible. More appropriate terminology would be that the consumption of certain fish is a risk to public health, especially pregnant women. The fish are edible; the mercury in them is a risk to the health of those who consume them.

Page 1, third paragraph, makes reference to the 1973 National Academy of Sciences guidelines to protect aquatic resources and their predators as a source of reliable information on excessive mercury accumulation in fish tissue. I was an invited peer reviewer for the National Academy of Sciences/National Academy of Engineering "Blue Book of Water Quality Criteria" (1972) which is the document which contains the values referred to in this paragraph. It has been found that the state of California Water Resources Control Board staff and only this staff have given far greater credence to the NAS/NAE "Blue Book" values developed in the early 1970s as providing reliable information on excessive concentrations of constituents in aquatic organism tissue as it may impact the organism or higher trophic level organisms. The so-called NAS values are not credible values for determining excessive concentrations of mercury or, for that matter, any other constituent in fish tissue.

Because of the persistence of the State Board and regional board staffs in continuing to use these values, I contacted Carlos Fetterlof who directed the "Blue Book" effort for the National Academies and who is also former chief biologist for the state of Michigan pollution control agency and served as the executive director for the Great Lakes Fisheries Commission for many years concerning his view on the appropriateness of the state of California using the so-called NAS values as a basis for judging excessive concentrations of constituents in fish tissue. Mr. Fetterlof confirmed my finding that the 1973 "Blue Book" values are not being appropriately used by the state of California. It should also be noted that the US EPA, the National Academies of Science, or no other state use the National Academy 1973 "Blue Book" values as credible values. They are not recognized by the National Academy bioaccumulation group as credible values for bioaccumulation in fish. In fact, when I contacted the director of that group a couple of years ago, he indicated that he had never heard of the NAS values for excessive concentrations of chemical constituents in fish tissue. The US EPA Region 9, the State Water Resources Control Board and the regional boards should immediately terminate any reference to the NAS values as having any credibility for determining excessive concentrations of any constituent in fish tissue as they may affect higher trophic level organisms.

Page 1, fourth paragraph, indicates that the State Water Resources Control Board has listed Delta waterways as use impaired because of excessive concentrations of mercury. It is my understanding that that information is significantly dated and may not be appropriate today. There are no recent concentration data on mercury content of fish tissue within the Delta. While it is believed, that the excessive concentration still exists, this needs to be confirmed through appropriately conducted studies. It is my understanding that funds have been made available through CALFED for this purpose.

Page 1, last paragraph, states, *"In general, large-scale, systematic sampling of a variety of fish species have not been conducted in the Bay."* The studies that were conducted as part of the BPTCP by the San Francisco Regional Water Quality Control Board represented a fairly comprehensive study of excessive bioaccumulation of hazardous chemicals, including mercury, within fish in the Bay. Further, this past summer additional sampling of this type was again conducted. When these data become available, there will be two fairly comprehensive studies conducted several years apart which provide data on the mercury content of fish within San Francisco Bay. The statement on the bottom of page 1 about the studies not being conducted is not in accord with what has been done.

On page 2, end of first paragraph, mention should be made about finding excessive mercury in fish taken from Putah Creek near where the University of California, Davis campus wastewaters are discharged to the Creek. Further, the UCD work referenced in the first paragraph of page 2 includes work on Cache Creek organisms. This should be mentioned.

Page 2, third paragraph, next-to-last line, uses the term "transvection." I do not understand that term. I taught aquatic chemistry for 30 years to graduate-level environmental engineering and

environmental science students. I have never heard the term "transvection." This problem likely exists for many others who may read this review. It should be explained.

Page 3, first full paragraph, states, *"More importantly, these sediments contain mercury in its most reactive forms."* I would be interested in seeing the technical back-up for such a statement.

Page 3, second full paragraph, places considerable emphasis on the mercury associated with hydraulic mining activities. While this may be justified, certainly of greater importance today in terms of CALFED program development is the input of mercury from Cache Creek. As discussed in my CALFED proposal of last summer, there is an urgent need to determine whether the mercury associated with high flow is in Cache Creek that enters the Yolo Bypass, the Delta and upper San Francisco Bay significantly contribute to excessive bioaccumulation of mercury. The focus of these studies must be on determining whether the expenditure of funds for controlling mercury input to Cache Creek will change the excessive bioaccumulation of mercury problem that exists in Delta and San Francisco Bay fish. There may be such a massive natural as well as anthropogenic mercury reservoir in the Delta and Bay that spending many tens to hundreds of millions of dollars controlling mercury inputs to the Bay will have no impact on the excessive bioaccumulation of mercury within Delta and Bay fish.

One of the primary issues that needs to be addressed is what specific forms of mercury contributed from Cache Creek lead to excessive bioaccumulation within the Bay and Delta.

Page 4, third paragraph, is extremely important but may be misleading where it states,

"Determining the relative contributions of the various sources (mercury mines, hydraulic mining debris, recycling from depositional areas) to the primary problem (methyl mercury in fish) is necessary to developing cost-effective solutions to the system's mercury problems."

There is need to understand the relative contributions of mercury from various sources. This understanding, however, must be based on mercury that is either in or can be converted to within the Delta and the Bay bioavailable mercury. The total mercury loads from various sources is not the issue that needs to be addressed. It is the mercury that contributes to the excessive bioaccumulation within the Delta and Bay that must be addressed to develop technically valid, cost-effective programs for controlling the mercury problems within the Delta and Bay.

Page 5, third paragraph, states,

*"UC Davis research - Davis Creek reservoir, Marsh Creek watershed, bioavailability
Researchers from UC Davis have determined that fish tissue concentrations can be predicted
from lower trophic level invertebrate concentrations."*

From my understanding of the data that exist, this statement is an inaccurate representation. While concentrations of mercury accumulate in insects, insect larvae and other benthic invertebrates, to my

knowledge there is not a clear, well-defined relationship between the concentrations in benthic invertebrates and fish.

Page 5, fifth paragraph, states, *"In December 1997, some CALFED Category 3 restoration funds were directed toward evaluating the effects of wetland restoration on methyl mercury production in the estuary."* It further states, *"This three-year study will quantify changes in methyl mercury production caused by restoration activities and evaluate the availability and impact of mercury of the Bay-Delta ecosystem."* That statement is not an accurate representation of what can be accomplished with these studies. First, under no circumstances will these studies evaluate the impact of mercury on the Bay-Delta ecosystem. These studies may provide some inference on some limited aspects of this issue. It is questionable, however, that they will even begin to address in a reliable way impacts on ecosystems. They may address, if properly implemented and reported, the transfer of mercury in sediments as part of the restoration area to benthic invertebrates and possibly to fish. It also should be understood that what might be accomplished in a three-year study of these types of issues may have limited applicability to longer term mercury transformations that will occur in CALFED shallow water habitat development projects. A three-year period is too short a period to follow the transformations that will occur in developing a wetlands-type habitat.

Page 5 presents an Action Plan/Strategy. The first item is to establish a Task Force to facilitate information exchange in development of a regional mercury strategy. This is an appropriate activity. The funds that I have requested from CALFED were specifically directed toward establishing a technical advisory panel (Task Force) of interest to stakeholders and independent peer reviewers. The efforts of the Central Valley Regional Water Quality Control Board staff, specifically Bill Croyle and Chris Foe, have already made significant strides toward establishing a technical advisory panel that could be of assistance to CALFED in formulating its mercury control strategy. There is however, need for support of this panel's activities of the type that are discussed in my proposal to CALFED where someone with a high degree of expertise, experience and demonstrated productivity would provide technical leadership and guidance in formulating and implementing the technical advisory panel (Task Force) activities.

Item 2 focuses on source identification and assessment studies. Source identification should focus on those forms that are converted within the Delta and Bay to methyl mercury that bioaccumulates in fish tissue. This item should be combined with item 3, directed research to better understand mercury cycling in the Central Valley and estuary.

Item 4, carrying out pilot mercury control programs and evaluating their effectiveness must focus on bioavailable forms of mercury and not necessarily total mercury. The key component of my proposal which must be one of the first phases in developing a technically valid, cost-effective control program for the Cache Creek mercury inputs is the determination of whether the additional mercury added to the Delta and Bay each year during high flow periods significantly contributes to the current bioaccumulation problem. More appropriately, would the expenditure of many millions of dollars to control this mercury input significantly change the excessive bioaccumulation of mercury in fish tissue within the Delta and Bay?

The second bulleted item on the bottom of page 5, mentions various types of studies. Inadequate attention is given in these studies to bioavailable mercury loads. This must be based on a proper assessment of how and to the extent a mercury load from a particular source when present in the Delta and Bay converts to methyl mercury. These issues appear to be covered to some extent by the first bulleted item on page 6.

The other action items listed are appropriate as far as they go. The key issue, though, will be finding an individual with high degrees of expertise and experience with mercury and water quality issues that can devote substantial time to helping CALFED and the stakeholders develop and implement a technically valid, cost-effective mercury control program who will provide technical guidance and conduct the activities needed to formulate a draft CALFED a mercury control strategy. When this strategy has been approved by stakeholders, the individual response would help CALFED and others implement it.

I have recently been in contact with colleagues who are involved in the Florida Everglades' mercury problem. This is also a large, multi-faceted program. This program is being hampered by a lack of strong technical leadership. The same kinds of problems could develop in the CALFED program, unless such leadership is provided. It is doubtful that the leadership will be developed without specific CALFED funding.

It is important to understand that my comments on the need for leadership are not based on an attempt to gain support for my activities. As indicated in the proposal, the work that I offered to do for CALFED in this area was going to be done at a significantly reduced consulting rate compared to my normal rates. I indicated that I would donate substantial consulting time to this issue if CALFED would provide the requested support. At this time, that offer still stands although since then I have acquired substantial research support for work in other parts of California on non-Delta related issues which will encumber much of the time that I have for donated services on behalf of CALFED or other groups.

If you have questions about these comments, please contact me. Please let me know if I can be of further assistance.

Sincerely yours,

FRED

G. Fred Lee, PhD, DEE

Copy to: W. Croyle, C. Foe, R. Woodard, G. Louis
GFL:jlc
Enclosure

Executive Summary

Development of a CALFED Management Approach for Controlling Excessive Mercury Bioaccumulation in Delta/Bay Fish

Submitted by
G. Fred Lee, PhD, DEE
G. Fred Lee & Associates

The Problem - The excessive bioaccumulation of mercury in edible fish tissue is one of the most significant causes of water quality use impairment in the Delta and San Francisco Bay. Many of the edible fish taken from these waters contain mercury concentrations that are considered to be a health threat to those who consume the fish. Mercury has been selected as one of the primary constituents of concern by the CALFED Bay/Delta program.

Some parts of the Delta watershed, such as the Cache Creek watershed, contain geological formations that have in the past and, to a lesser extent, today provided economic mineral resources that have been mined for mercury and other elements such as gold where mercury was used for gold recovery. These mining activities have resulted in pollution of areas with mine tailings and processed ore residues which contain concentrations of total mercury that could potentially cause excessive bioaccumulation within aquatic life tissue in the area where the mercury residues are found and downstream. The CVRWQCB staff have found that large amounts of mercury are transported to the Delta in the high winter/spring stormwater runoff flows in tributary waters to the Delta. Of particular importance is the Cache Creek watershed which has been identified as one of the dominant sources of total mercury for the Delta.

It has been known for many years that chemical constituents such as mercury exist in aquatic systems in a variety of chemical forms, only some of which are toxic/bioaccumulatable. For mercury, it is well understood that there is little relationship between the total mercury content in a water or a waterbody's sediments and the total concentration of mercury that bioaccumulates in fish tissue. Total mercury content in Delta or Bay waters as well as total mercury fluxes to the Delta and/or Bay is an unreliable predictor of water quality problems associated with mercury. Unless correctly formulated, CALFED could develop a mercury management program that would spend large amounts of funds in mercury input control that has little or no impact on the excessive mercury bioaccumulation problem that occurs within the Delta and Bay as well as some of the Delta tributaries. It is essential that CALFED's mercury control program be based on incorporation of appropriate mid-1990 science and engineering understanding of the potential water quality significance of each of the potential sources of mercury as they impact the excessive bioaccumulation problem within the Delta and Bay fish. Further, there is need to develop an understanding of the potential benefits of controlling mercury input to the Delta and Bay from a particular source or types of sources on the magnitude of reduction of the excessive bioaccumulation of mercury in fish tissue.

In order for CALFED and other agency funds available for mercury control to be used in a technically valid, cost-effective manner, there is need for a highly technical organized effort to determine which of the sources of mercury within the Delta watershed contribute mercury to the Delta and Bay in a form that is present in or converted to mercury forms that can bioaccumulate in Delta and/or Bay fish. In addition, CALFED's mercury management program should be based on sufficient understanding of mercury load to the Delta/Bay - fish bioaccumulation response relationships to enable an evaluation of the cost-effectiveness of implementing mercury control to various degrees from various sources.

The overall objective of this project is to fund a CALFED effort that will enable CALFED to formulate the most technically valid, cost-effective mercury control program that can be developed through near term, site specific investigations of the potential significance of various forms of mercury from various sources as a contributor to the excessive mercury bioaccumulation problem that exists in Delta and Bay fish.

Approach - Dr. G. Fred Lee will serve as a consultant to CALFED management, formulating a mercury control strategy. This strategy will provide the technical basis for CALFED's mercury control program. The funding of this proposal will provide Dr. Lee with the resources necessary to spend additional time on these issues beyond his already voluntary contribution of time and resources to formulation of a mercury control strategy for the Delta and Bay. In addition, the funds in this proposal will allow Dr. Lee to organize in cooperation with CALFED management, regulatory agency representatives, and mercury researchers in the area, a technical advisory panel of national/international environmental mercury experts. This panel will provide independent peer review of the approaches being used to formulate the CALFED mercury control strategy.

Budget - The first year of this three year project has a proposed budget of \$70,750.00. \$27,000.00 of this amount is devoted to supporting three technical consultants attending two meetings per year. The remainder of the funds is devoted to the support of Dr. Lee's time, serving as an advisor to CALFED as project facilitator.

Qualifications - For a 30 year period, until 1989, Dr. Lee taught graduate environmental engineering and environmental science courses at several major US universities. During this time, he conducted over five million dollars in research devoted to defining the sources, water quality and public health significance, and developing control programs for chemical constituents in aquatic systems. He has published over 650 papers and reports on his work. Since 1989, he has been a full-time consultant to governmental agencies and industry in the US and other countries in water supply water quality, water and waste water treatment, water pollution control including mining wastes and Delta water quality issues, and solid and hazardous waste management.

Monitoring and Coordination - This project will formulate approaches for monitoring the efficacy of CALFED mercury control programs. It will be coordinated with regulatory agencies, mercury researchers, and all other parties interested in managing the excessive mercury bioaccumulation problem that is occurring in the Delta/Bay.

**Development of a CALFED Management Approach for Controlling
Excessive Mercury Bioaccumulation in Delta/Bay Fish**

Submitted by

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Many other individuals concerned with excessive mercury bioaccumulation
are anticipated to be participants in this project.

RFP Project Group Type: Other Services

Project Description

Background

The excessive bioaccumulation of mercury in edible fish tissue is one of the most significant causes of water quality use impairment in the Delta and San Francisco Bay. Many of the edible fish taken from these waters contain mercury concentrations that are considered to be a health threat to those who consume the fish. The California Department of Health Services has issued fish consumption health advisories for fish taken from San Francisco Bay because of excessive concentrations of mercury. Because of this situation, mercury has been selected as one of the primary constituents of concern by the CALFED Bay-Delta program. One of the overall objectives of the CALFED program is the management of mercury input to the Delta and through the Delta into the Bay to reduce the concentrations of mercury in edible fish tissue to levels that do not represent a public health risk to those who use the fish as food.

Some parts of the Delta watershed, such as the Cache Creek watershed, contain geological formations that have in the past and, to a lesser extent, today provided economic mineral resources that have been mined for mercury and other elements such as gold where mercury was used in gold recovery. These mining activities have resulted in pollution of areas with mine tailings and processed ore residues which contain concentrations of total mercury that represent a potential threat of causing excessive bioaccumulation within aquatic life tissue, both in the areas where the mercury residues are found and downstream. Further, there are natural hot springs that discharge mercury to tributary waters of the Delta. The Central Valley Water Quality Control Board (CVRWQCB) staff have found that large amounts of mercury are being transported to the Delta each year by the high winter/spring storm water runoff flows of some of the Delta's tributary waters. Of particular importance is the Cache Creek watershed which has been identified as one of the dominant sources of total mercury for the Delta.

It has been known for many years that chemical constituents such as mercury exist in aquatic systems in a variety of chemical forms, only some of which are toxic/bioaccumulatable. For mercury, it is well understood that there is little relationship between the total mercury content in a water or a waterbody's sediments and the total concentration of mercury that bioaccumulates in fish tissue. Total mercury content in Delta or Bay waters as well as total mercury fluxes to the Delta and/or Bay is an unreliable predictor of water quality problems associated with mercury. CALFED, through developing a mercury management program which fails to appropriately incorporate the aqueous environmental chemistry of mercury that leads to excessive bioaccumulation, could spend large amounts of public funds in mercury input control programs that have little or no impact on the excessive mercury bioaccumulation problem that occurs within the Delta and Bay as well as some of the Delta tributaries. It is necessary that CALFED's mercury control program be based on incorporation of appropriate mid-1990 science and an engineering understanding of the potential water quality significance of each of the potential sources of mercury as they impact the excessive bioaccumulation problem within the Delta and Bay fish. Further, and most importantly, there is need to develop an understanding of the potential benefits of controlling mercury input to the Delta and

Bay from a particular source or types of sources on the magnitude of reduction of the excessive bioaccumulation of mercury in fish tissue.

Approach

Dr. G. Fred Lee will serve as a consultant/assistant/implementor to CALFED management, CVRWQCB, WRCB, and US EPA, university and governmental agencies (USGS Fish and Wildlife Service, etc.), researchers and others as appropriate to help CALFED formulate a mercury control strategy. This strategy will provide the technical basis for CALFED's mercury control program. The funding of this proposal will provide Dr. Lee with the resources necessary to spend additional time on these issues beyond his already voluntary contribution of time and resources to formulation of a mercury control strategy for the Delta and Bay.

In addition, the funds in this proposal will allow Dr. Lee to organize, in cooperation with CALFED management, regulatory agency representatives, and mercury researchers in the area, a technical advisory panel of national/international environmental mercury experts who can provide independent peer review of the approaches being used and formulate the CALFED mercury control strategy as well as the specific research that will be funded through CALFED that serves as the technical basis for obtaining the information needed to implement the CALFED mercury control strategy.

A project technical advisory group will be organized by Dr. G. Fred Lee and CALFED who will work with Dr. Lee on the week-to-week activities of the project. This group will consist of 3 to 5 individuals who are interested and knowledgeable on one or more aspects of the Delta/Bay mercury problem as well as potential sources of mercury for the Delta/Bay. While considerable amounts of the work of this group will be done through e-mail correspondence and conference calls, periodic (likely monthly) meetings of the project advisory group will be held to discuss specific issues more thoroughly than is possible through electronic communication. Over the past year, Dr. Lee has been involved in several groups that operate largely through e-mail/conference calls. This approach has proven highly effective in carrying out group activities at a considerably reduced cost.

Project Location

The primary area of focus in this project is the Delta and the upper parts of Northern San Francisco Bay where mercury derived from the Delta is expected to accumulate in the Bay. Of particular concern within the Delta and Bay are those areas where mercury added to these waters would accumulate in the sediments and be converted to methyl mercury that accumulates in recreational and other fish to excessive concentrations that cause the use of these fish as food to be considered hazardous to human health.

The second location where the project activities will be focused is in the Cache Creek watershed that contributes mercury to the Delta with its high winter/spring stormwater runoff. As additional work is done in the Sacramento River Watershed Project on mercury sources for the

Sacramento river system that contribute potentially significant amounts of mercury to the Delta and as additional potentially significant mercury sources are defined, the source areas for this mercury will become additional areas of focus for the project.

Expected Benefits and Need for Project

The primary benefits from this project will be the development and implementation of a technically valid, cost-effective CALFED mercury management program that will control the mercury inputs to the Delta and Bay that lead to excessive bioaccumulation of mercury in edible fish tissue. This project will provide the technical information base upon which CALFED can formulate its mercury management strategy. The organization of a high level technical expertise advisory activity for the development and implementation in formulating a mercury control program for Delta and Bay inputs that is based on current science and engineering to the maximum extent practicable is essential for CALFED in order to address the control of excessive mercury bioaccumulation.

Proposed Scope of Work

The funds derived from this project will enable Dr. G. Fred Lee to significantly expand his current voluntary technical assistance in formulating technically valid, cost-effective mercury control programs to the Delta and Bay. Since returning to California in 1989, Dr. Lee has been active in Delta and Bay water quality issues. One of the areas of particular concern to him has been the addition of potentially hazardous chemicals to these systems and those chemicals' impacts on aquatic resources. With the discovery through the SFEI Regional Monitoring Program that many of the Bay fish have excessive mercury in their edible tissue compared to current US EPA guidelines and CVRWQCB staffs finding of high mercury inputs to the Delta associated with high winter/spring Cache Creek flows to the Delta, Dr. Lee has devoted time to review the potential significance of the particulate mercury transported during high flow periods as a cause of the excessive mercury that is bioaccumulating in Delta and Bay fish. Dr. Lee's concern in this matter stemmed from his early 1990's work on behalf of the American Dental Association which indicated that certain forms of mercury were not converted to methyl mercury at a high rate or at all and thereby contribute to excessive bioaccumulation of mercury in fish tissue.

After becoming aware of the high mercury loads being transported to the Delta via Cache Creek, Dr. Lee contacted the CVRWQCB indicating the need to better understand the aqueous environmental chemistry of particulate mercury present in the high tributary flow waters with particular reference to whether this mercury was in a bioavailable form or could be converted to such a form within the Delta or Bay. Over the past several years, Dr. Lee has spent time becoming familiar with the literature pertinent to what is known today about the bioavailability of various forms of mercury in various aquatic environments. He has also devoted attention on how to determine whether mercury from a particular source added to a particular water body would likely be a significant factor in causing or contributing to excessive mercury bioaccumulation. He has discussed this situation with many individuals including an ad hoc Cache Creek Mercury Group

organized by Chris Foe of the CVRWQCB. There seems to be considerable interest in this area and a general consensus that work on this topic needs to be done before the CVRWQCB/CALFED can formulate its mercury control strategy for controlling mercury input to the Delta.

Dr. Lee has also become familiar with the problem through serving as a reviewer to the Sacramento County Sanitation District's sponsored recently completed mercury studies associated with some of the gold mining areas in the Sierras. He has also become familiar with the excessive bioaccumulation problem associated with fish taken from Putah Creek near the University of California's campus waste water treatment plant discharged to the Creek. Dr. Lee has recently been invited to become an active participant in the Cache Creek Mercury Technical Workgroup. At a recent meeting of this group, there seemed to be considerable interest in, and need for the developing the kind of program that has been formulated as part of this project proposal. Dr. Lee's specific responsibilities in this project will be to serve as an organizer and implementer of a CALFED activity that is designed to provide CALFED with a current assessment with what is known about the issues that need to be addressed in formulating and implementing a CALFED mercury control strategy.

Dr. Lee will be an organizer and synthesizer of technical information for CALFED on technical issues that should be incorporated into the CALFED mercury control strategy. Because of his technical expertise and experience, with CALFED's financial support for this project he will develop draft issue papers pertinent to formulating the CALFED mercury control strategy. A discussion of important technical issues that need to be resolved in the form of issue papers is included in the Appendix. These issue papers will first be reviewed by the project's technical advisory group and then, after redrafting, will be circulated to anyone interested in the current Delta/Bay mercury bioaccumulation problem, and/or its management, for their review and comment.

The first of the issue papers will be a synthesis of what is known about developing technically valid cost-effective mercury control programs for the Delta and the Bay. This issue paper will also discuss the major data gaps that need to be addressed and how they should be addressed by site specific research associated with the conversion of various forms of mercury in water and sediments into bioaccumulatable forms (methyl mercury) that bioaccumulate in fish tissue. The issue paper would develop consensus statements on issues where the strengths and weaknesses of any particular position that is important to formulating a CALFED mercury management strategy is fully discussed. It is Dr. Lee's intent to hold periodic meetings of all interested parties in the development of the CALFED mercury strategy and its implementation.

Since many of the same issues pertinent to developing a mercury control strategy for the Delta/Bay are pertinent to developing a mercury control strategy for mercury bioaccumulation problems in Cache Creek, Dr. Lee will discuss these issues with those participating in the Cache Creek Mercury Technical Workgroup as well as with others. He will offer to make presentations to the Cache Creek Mercury group on various components of the issue papers as they are drafted and will invite comments on redraft and final papers.

It is anticipated that this initial mercury management issue paper will be completed within four to six months. It will serve as a guide to CALFED on how to allocate resources for developing and implementing a mercury control strategy. As new information becomes available from the literature or from site specific studies, some of which will likely be funded by CALFED, Dr. Lee will update his consensus statement on how CALFED should develop and implement a Delta/Bay mercury control strategy. Dr. Lee plans to meet with CALFED water quality management on at least monthly intervals and will provide summary reports on activities for each month.

The other primary activity associated with funding of this proposal will be the development of a national/international panel of consultants who would meet twice a year with CALFED management, Delta/Bay and Cache Creek mercury researchers and other interested parties to review proposed plans and accomplishments in developing a CALFED mercury control strategy. The first meeting of this panel will take place about six months after initiation of the project and after the draft initial guidance paper has been distributed to interested parties and comments have been received. The consulting panel will be requested to review the second draft of the CALFED guidance document associated with the formulation of the CALFED mercury control strategy. It is possible that a second meeting of this panel will take place near the end of this first project to review their accomplishments during the first year and to develop recommendations on the second year's activities .

At a recent Cache Creek Mercury Technical Workgroup, there was consensus about the need for independent peer review of CALFED mercury projects by knowledgeable experts who do not have specific research projects underway that could be interpreted as a conflict of interest between reviews that they may provide on other projects. The national/international technical advisory panel that will be organized by Dr. Lee, CALFED, and the project technical advisory group, will provide the independent review of specific research components of the CALFED mercury strategy as well as the overall strategy.

One of the key components of Dr. Lee's approach towards providing guidance to CALFED on the development of a mercury management strategy will be the formulation of a mathematical model that incorporates what is known about the key source release, transport, and transformations of various forms of mercury from various sources within the Delta's watershed that are transported to the Delta and Bay that lead to excessive bioaccumulation of mercury within Delta and Bay fish. At Dr. Lee's suggestion, a review of one of the potential models that could be used for this purpose will be conducted at the September 5, 1997 Cache Creek Mercury Technical Workgroup meeting. This and other potential models will be reviewed by Dr. Lee and others as appropriate in order to evaluate their representation of what is now known about mercury transport and transformations.

It has been Dr. Lee's experience, having been involved in modelings of this type since the 1960's, that such models have limited predictive capability and rarely can be used to predict with reliability the impact of altering a contaminant's load to a waterbody on the impact of the constituent on the beneficial uses of the waterbody. Such modeling efforts, however, can be important in

systematically organizing the understanding of processes of potential concern, and thereby guide the development of studies to provide the information needed to formulate a management strategy.

By the end of the first year, as a result of funding this project, CALFED will have available a fairly delineated course of action for developing and implementing a Delta/Bay mercury control strategy. Initial steps toward its implementation could begin during this period. Based on the current understanding of issues, some of the key components of the strategy could not be formulated until site specific studies have been completed. This project will develop a consensus on these specific components with respect to what needs to be done and how this information will be used in the strategy.

By mid-second year, several of the CALFED projects as well as projects supported by other sources, should begin to release results that can be incorporated into refining the CALFED mercury management strategy. It will be Dr. Lee's responsibility to develop a review evaluating the adequacy of new information obtained from the literature and from CALFED sponsored research pertinent to the development and implementation of a mercury management strategy. Dr. Lee will incorporate the new information into the revised strategy document as it becomes available. He plans to meet with all interested parties at least quarterly and, more likely, at bi-monthly to monthly intervals to review new developments and refinements of the proposed strategy.

Further, during the second year Dr. Lee will be developing a guideline for monitoring the impacts of mercury input control that can be used at site-specific locations to establish the cost effectiveness of control programs. The monitoring programs will likely incorporate special purpose studies that can provide early indications of ineffective and effective control strategies. This monitoring will likely include studies of bioaccumulation near the mercury source such as in Cache Creek or its tributaries in order to assess if near source controls of mercury input impact the degree of bioaccumulation that is occurring in nearby downstream waterbodies. Since this approach might not be a reliable indicator of what happens in the Delta or Bay, with respect to conversion of a certain form of mercury into bioaccumulatable forms because of the differences in the physical, chemical, and biological characteristics of the water and especially the sediments, it will be important to characterize each of the environments, i.e. near source and Delta/Bay, sufficiently to be able to reliably translate the results from one area to another.

The third year of the project will be devoted to continued modifications of the strategy as new information becomes available and components of the strategy are increasingly implemented. By then, fairly definitive information should be available on the forms of the mercury and various types of sources that will most likely lead to excessive bioaccumulation of mercury in Delta and Bay fish tissue.

Regulatory Requirements for the Control of Mercury

Since the beneficial uses of both the Delta and Bay are impaired due to the excessive mercury concentrations in Delta and Bay fish, the current regulatory requirements mandate that all NPDES

regulated point sources of mercury such as domestic and industrial wastewater discharges, control mercury inputs to the Sacramento River, Delta, and Bay so that the concentrations in the discharge do not cause a water quality objective violation in the receiving waters. For NPDES regulated urban and industrial stormwater runoff, the control of mercury in the runoff waters should prevent exceedance of water quality objectives in the receiving waters to the maximum extent practicable using best management practices. The control of mercury input from other non-point sources is less well defined. Basically, it seems to be generally agreed that, for such sources as mine tailings, control should be implemented to the extent that financial resources will allow in order to reduce the impact of the mercury sources on the beneficial uses of the receiving waters by runoff/discharges from these sources. CALFED, therefore, has the option of developing a mercury management strategy that will enable the control of the excessive bioaccumulation that is occurring within Delta and Bay fish focusing on those sources which are the principle sources of bioaccumulatable mercury.

The CVRWQCB has the responsibility of developing a wasteload allocation and total maximum daily loads (TMDL) for mercury input into the Delta as a result of the water quality limitation arising from the mercury caused impairment of the Delta waters. The US EPA, the State Water Resources Control Board, and the Central Valley Regional Water Quality Control Board need assistance in developing guidelines for the formulation of contaminant control programs for toxic and/or bioaccumulatable chemicals. While the US EPA has developed guidance for developing TMDL's for oxygen demand-BOD and nutrients, the agency has not yet developed TMDL guidance for potentially toxic chemicals as well as those that tend to bioaccumulate. Dr. Lee is working with the Santa Ana Regional Water Quality Control Board in formulating approaches for developing TMDL's for toxic chemicals entering upper Newport Bay. This work will include those chemicals that tend to bioaccumulate in upper Newport Bay and its tributary aquatic life, such as mercury. The upper Newport Bay work will have applicability to the mercury management situation in the Delta watershed and Delta.

The CVRWQCB, WRCB, and the US EPA will be invited participants in this project. They will, therefore, have unofficial roles in helping to carry out this project and formulate the CALFED mercury management strategy. The development of this strategy will be fully in accord with current regulatory requirements, and shall anticipate, to the extent possible, changes in these requirements that may arise from revised regulations issued by the US EPA and Congress. Because of the cooperative approach being used in this project, it is anticipated that the recommended CALFED mercury management strategy will be fully implementable from a technical and regulatory perspective.

Additional information pertinent to the Project Description, with emphasis on Technical Justification, is provided as an Appendix. The overall length of this proposal, including this Appendix, conforms to the overall RFP guidelines where the Appendix utilizes some of the Qualifications and Cost and Schedule allowed space.

Costs and Schedule

Budget

The proposed budget for the first year of this project is presented in Table 1. The project can be implemented as soon as funds are made available. The anticipated funding levels for the second and third years are the same as for the first. As indicated in Table 1, the CALFED funds will be used to support Dr. Lee's activities presented in the Scope of Work in which he serves as a technical resource and high level technical expertise facilitator and synthesizer of information from the literature and recent and ongoing studies, principally in the Cache Creek watershed into a recommended CALFED mercury management strategy.

Discussion of Budget

Dr. Lee proposes to devote an average of five hours per week on this project for which he will be compensated at less than half of his standard consulting rate for governmental agencies and industry. He has proposed to adjust his normal consulting rate from the current \$225 per hour to \$100 per hour for this project. He will, therefore, donate in excess \$32,000 in support of the development and implementation of the CALFED mercury management program. This contribution will be his cost-share toward the project.

The billing rates for Dr. Lee are rates which include his total costs. The total costs include all costs, except for employee expenses associated with the project and travel costs. There are no overhead/indirect costs, multipliers, fees or separate profit items associated with these rates. Dr. Lee has been active as a consultant to governmental agencies, industry, and others utilizing this approach for budgeting his consulting activities. Since Dr. Lee's activities are primarily that of a consultant to CALFED in the development of a mercury management strategy, it is appropriate to continue this budgeting approach for this project.

While no funds are budgeted for the support of Dr. Anne Jones-Lee (Dr. G. Fred Lee's wife), she will, as needed, be an active participant in the project. Her activities will be primarily focused on providing advice on the aquatic biology/aquatic toxicology components of the project, as well as in the project report preparation. She will donate her time on behalf of the project as needed.

This project will be coordinated with the activities of all others concerned with mercury problems in the Delta and Bay. It will provide the technical leadership for various groups to help formulate local mercury control programs within the Delta watershed. This project is fully compatible with CALFED's objective of providing good water quality for all beneficial uses.

Schedule Milestones

The anticipated milestones for this activity have been presented and discussed under **Scope of Work**. There are no third party impacts from this project that would require mitigation.

Table 1

**Budget
Year One of a Three Year Project**

Budget period is one year.
The project can be initiated upon award of contract.

Personnel:

Dr. G. Fred Lee, PhD, DEE	
5 hrs/week for one year @ \$100/hr.	\$26,000.00
Hourly help	
500 hrs @ \$18/hr.	9,000.00
Secretarial	
250 hrs @ \$15/hr.	<u>3,750.00</u>
 Total Personnel	 \$38,750.00

Expenses

Travel: Miscellaneous travel Sacramento region	500.00
Telephone/Fax/Photocopies	4,500.00
 Total Travel and Supplies	 <u>\$5,000.00</u>

Professional Advisory Services

Technical Consultants Honoraria	
Three Consultants @ \$5,000 per year	15,000.00
Technical Consultants Travel	
2 Meetings Per Year	
Airfare	7,500.00
Other Travel Expenses	2,500.00
Technical Consultants Non-Meeting Expenses	2,000.00

Total Technical Consultants \$27,000.00

Total Budget: \$70,750.00

The anticipated budget for the second and third year of this project are expected to be approximately the same as the first year's budget.

Qualifications

Dr. Lee has a PhD degree from Harvard University obtained in 1960 with an emphasis in environmental engineering, environmental sciences, and aquatic chemistry. He obtained a Master's degree in Public Health in 1957 from the University of North Carolina. For a 30 year period, until 1989, Dr. Lee taught graduate environmental engineering and environmental science courses at several major US universities. During this time, he conducted over five million dollars in research devoted to defining the sources, water quality, and public health significance of chemical constituents in aquatic systems, as well as developing control programs for them. He has published over 650 papers and reports on his work.

Since 1989, he has been a full-time consultant to governmental agencies and industry in the US and other countries in water supply water quality, water and waste water treatment, water pollution control (including mining wastes and Delta water quality issues) and solid and hazardous waste management. For several years in the early 1990's, he was a consultant to the American Dental Association on environmental mercury issues. He is no longer active in that role and does not have a conflict of interests in undertaking this proposed project. He is currently serving as a member of a CVRWQCB Cache Creek Mercury Technical Workgroup. He is also active as a voluntary participant in the Sacramento Watershed Management Program.

A key component of this project is the development of a consensus pertinent to providing guidance on the development of the CALFED mercury control strategy. The development requires that the developer have high expertise in the field and be able to present a discussion of key issues in a issue paper on the topic. These are areas in which Dr. Lee has extensive experience and expertise. One of Dr. Lee's primary interests is working toward the incorporation of good science and engineering into formulation of public policy for water quality management. His extensive past and current publication productivity demonstrates his interest and effectiveness in developing technical materials that can be used to formulate technically valid, cost-effective public policy for environmental quality management.

Further information of Dr. Lee's qualifications to undertake this project has been provided in the Project Description.

Dr. Lee has extensive experience in developing programs of this type and as serving as a member on expert panels on major water quality management issues. Addition information regarding Dr. Lee's expertise and experience pertinent to this project is included in his web site (<http://members.aol.com/gfredlee/gfl.htm>).

Compliance with Standard Terms and Conditions

Dr. Lee does not anticipate any problems complying with Terms and Conditions set forth in Attachment D to the RFP.

**Appendix
Supplemental Information
Project Description**

Ecological Significance of Mercury Contamination

While there is a well identified public health problem associated with excessive mercury bioaccumulation in Delta and Bay fish, there may also be ecological problems associated with mercury bioaccumulation and toxicity to aquatic life and terrestrial life (amphibians, mammals and birds) that depend on Delta aquatic resources as food. Although the focus of this project is on the quality of the edible aquatic resources associated with the Delta and Bay (i.e. excessive mercury bioaccumulation in edible fish tissue), there is growing concern about mercury not only being a hazard to human health but also to aquatic life, especially terrestrial life such as animals, birds and amphibians that eat fish or insects that accumulate mercury in their tissue. Current research being conducted by the Fish and Wildlife Service is directed toward examining these issues in the Cache Creek watershed. It is likely that, to the extent that there is an ecological impairment problem associated with the bioaccumulation of mercury in Delta and Bay fish, the results of this project will also have direct applicability to controlling any ecological problems that may exist due to high mercury inputs to the Delta from natural and anthropogenic sources.

Need to Prioritize Remediation Funding

From a water quality management perspective, ideally there would be sufficient funds within CALFED and other organizations to control the mercury and all other potential pollutant inputs to tributaries of the Delta as well as the Delta and Bay from both anthropogenic and natural sources. However, funding restrictions require that the funds available for managing water quality problems associated with the Delta and its tributaries be focused on controlling the water quality use impairment for mercury excessive bioaccumulation in a technically valid, cost-effective manner.

In order for CALFED and other agency funds available for mercury control to be used in a technically valid, cost-effective manner, there is need for a high technical level, organized effort to determine which of the sources of mercury within the Delta watershed contribute mercury to the Delta and Bay in a form that is present in or converted to mercury forms that can bioaccumulate in Delta and/or Bay fish. In addition, CALFED's mercury management program should be based on sufficient understanding of mercury load to the Delta/Bay fish bioaccumulation response relationships to enable an evaluation of the cost-effectiveness of implementing mercury control to various degrees from various sources.

CALFED's funding of this project will enable CALFED to formulate the most technically valid, cost-effective mercury control program that can be developed through near-term, site specific investigations of the potential significance of various forms of mercury from various types of

sources as a contributor to the excessive mercury bioaccumulation problem that exists in Delta and Bay fish.

Technical Justification

While water quality management programs are sometimes based on factors other than the current state of science and engineering, such as regulatory constraints, CALFED has both the opportunity and the obligation to the public to formulate and implement the most technically valid, cost-effective approach for managing the excessive mercury bioaccumulation problem that is occurring today in Delta and Bay fish. The total magnitude of funding required to control all mercury sources for the Delta to concentrations below those that could potentially lead to excessive bioaccumulation is far greater than the funds available for such control. Further, in addition to the need for funds for mercury control there is also need for funds both for other constituent input control as well and for restoration of the Delta's water quality and ecosystems. Because of the limited funding available compared to the magnitude of Delta problems, it is essential that all Delta water quality management funding be based on properly evaluated water quality problems in which the specific constituents responsible for water quality use impairment are controlled at the sources. This approach will require that CALFED support the development of information that determines bioavailable forms of constituents and their specific sources. With this type of information it will be possible for CALFED to evaluate and prioritize how CALFED funding can and should be spent to maximize water quality improvement in the Delta associated with the mercury pollution problem. This project will provide the information needed by CALFED to develop a mercury control strategy.

This project will focus on the development of information that can address several key technical issues that must be resolved before CALFED can develop a technically valid cost-effective mercury control strategy. The ad hoc mercury group organized by the CVRWQCB staff has had several meetings where mercury issues have been discussed. These discussions have raised questions about the water quality significance of the high flow mercury that enters the Delta each year from the Cache Creek watershed. There are some mercury researchers who express the view that since most of this mercury is apparently in a stable mineral form (cinnibar), the large loads of mercury associated with the high winter/spring flows may have little or no impact on the excessive mercury bioaccumulation problem that occurs within the Delta and Bay. Under these conditions, large amounts of money could be expended controlling the erosion of mercury mine tailings and spent ore deposits and have no impact on the amount of mercury present in edible fish tissue within the Delta and San Francisco Bay.

There are also some researchers who believe that the natural sources of mercury such as the thermal springs in the Cache Creek watershed may be an important source of the mercury that converts to methyl mercury and causes excessive bioaccumulation. If this is the case, then CALFED's funds should be spent developing treatment works for the thermal spring water to remove the mercury from these waters before they enter the larger water courses that eventually reach the Delta.

Some mercury experts express the view that San Francisco Bay and Delta fish may have always had excessive mercury in their tissue compared to current regulatory limits due to natural inputs of mercury to the Delta/Bay. There seems to be considerable consensus among mercury researchers that the existing mercury pool within the Delta and Bay may be sufficient so that the initiation of major control efforts for upstream sources of mercury, such as from former mining activities, may have no impact on the excessive mercury bioaccumulation problem within the Delta and Bay for many decades to hundreds of years or more. If it is concluded from appropriately conducted research that spending large amounts of CALFED money in controlling particulate mercury input to the Delta will likely have little or no impact for very long periods of time on the excessive mercury bioaccumulation problem, then it may be appropriate for CALFED to assign a different priority to control of the high winter/spring flow mercury inputs to the Delta than would be assigned if studies show that there is reasonable likelihood that reducing mercury inputs to the Delta associated with these flows would be expected to cause a discernible impact in the magnitude of the mercury bioaccumulation problem that is occurring in the Delta/Bay.

It is evident that there are several basic issues that must be resolved through appropriately conducted investigations before CALFED can formulate a technically valid, cost-effective strategy for mercury input control. It is important, as part of formulating and implementing a CALFED mercury control strategy, to gain a substantially better understanding of the potential role of each of the mercury sources for the Delta and Bay as a contributor to excessive mercury within the Delta/Bay fish.

One of the initial primary goals of this project will be the development of a discussion of current information on the Delta/Bay mercury problem and the potential sources of mercury that lead to this problem. Dr. Lee will also include in this discussion a review of ongoing research that is relevant to managing the mercury problem in the Delta/Bay. This effort will identify significant information gaps that must be filled in order for CALFED to formulate its mercury control strategy. Dr. Lee will work with the project advisory group to delineate specific research areas that are not currently being addressed to define the significance of mercury from a particular type of source as a cause of excessive bioaccumulation of mercury in Delta/Bay fish. Dr. Lee and the project advisory group will work with CALFED in formulating the components of needed specific research/studies, identifying researchers to carry out the projects and provide technical review of the results during the course of the project and upon completion.