Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Project Information

1. **Proposal Title:**

   Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

2. **Proposal applicants:**

   Lester McKee, San Francisco Estuary Institute
   Bruce Thompson, San Francisco Estuary Institute
   Donald Yee, San Francisco Estuary Institute
   Jon Leatherbarrow, San Francisco Estuary Institute
   Ben Greenfield, San Francisco Estuary Institute
   Lynne Curry, San Francisco Estuary Institute
   Frank Leung, San Francisco Estuary Institute
   Khalil Abu-Saba, Applied Marine Sciences
   Andy Gunther, Applied Marine Sciences
   Russ Flegal, University of California Santa Cruz

3. **Corresponding Contact Person:**

   Lester McKee
   San Francisco Estuary Institute
   1325 South 46th Street, Richmond, CA 94804
   510 231 9578
   lester@sfei.org

4. **Project Keywords:**

   Heavy Metals (mercury, selenium, etc.)
   Modeling
   Water Pollution, Non-point Source

5. **Type of project:**

   Research

6. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

7. **Topic Area**:

   Ecosystem Water and Sediment Quality

8. **Type of applicant:**

   Private non-profit

9. **Location - GIS coordinates:**

   Latitude: 38.29793

   Longitude: -122.29990

   Datum:

   Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

   The project will sample a number of river locations in the Napa River Watershed, Napa County, California. The Napa River Watershed covers an area of 420 square miles and is the largest of the watersheds entering San Pablo Bay west of the Delta. The project will also samples a transect of wetlands and sloughs (the Baylands) from Suisun Bay to San Pablo Bay.

10. **Location - Ecozone:**

    2.1 Suisun Bay & Marsh, 2.2 Napa River, 2.5 San Pablo Bay

11. **Location - County:**

    Napa, Solano

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    California, 1st

15. **Location:**

    California State Senate District Number: 2

California Assembly District Number: 07

16. **How many years of funding are you requesting?**

 3

17. **Requested Funds:**
 a) Are your overhead rates different depending on whether funds are state or federal?

 No

 If no, list single overhead rate and total requested funds:

Single Overhead Rate:	153
Total Requested Funds:	$694183.04

 b) Do you have cost share partners already identified?

 No

 c) Do you have potential cost share partners?

 No

 d) Are you specifically seeking non-federal cost share funds through this solicitation?

 No

 If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. **Is this proposal for next-phase funding of an ongoing project funded by CALFED?**

 No

 Have you previously received funding from CALFED for other projects not listed above?

 Yes

 If yes, identify project number(s), title(s) and CALFED program.

99-N07	**Chronic toxicity of environmental contaminants in Sacramento splittail**	**CALFED Bay-delta Program**
00-E04	**Sonoma Creek Watershed**	**CALFED Watershed Program**
99-B06	**Association of ecological and human health impacts with Mercury in the Bay-delta**	**CALFED Bay-delta Program**

0145	**Stewardship Support and Watershed Assessment in the Napa River Watershed: A Two-year Project, CALFED Bay-delta Watershed Program (funded 2001)**	**CALFED Bay-delta Watershed Program**

19. **Is this proposal for next-phase funding of an ongoing project funded by CVPIA?**

    No

    Have you previously received funding from CVPIA for other projects not listed above?

    No

20. **Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?**

    No

    Please list suggested reviewers for your proposal. (optional)

David Schoellhamer	**USGS**	**916 278-3126**	**dschoell@usgs.gov**

21. **Comments:**

    We have no comments

Environmental Compliance Checklist

<u>Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.</u>

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      No
   b) Will this project require compliance with NEPA?

      No
   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

      Upon approval of this proposal, SFEI will work the California Department of Water Resources in matters of environmental compliance. For the purposes of this project we believe that we are categorically exempt from the California Environmental Quality Act (CEQA)and from the National Environmental policy act (NEPA). Section 15306 of the CEQA Guidelines provides a categorical exemption for information collection projects that consist of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. The section goes on to note that these information collection projects may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not yet approved, adopted, or funded.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   <u>CEQA Lead Agency:</u>
   <u>NEPA Lead Agency (or co-lead:)</u>
   <u>NEPA Co-Lead Agency (if applicable):</u>

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

   CEQA
   -Categorical Exemption
   -Negative Declaration or Mitigated Negative Declaration
   -EIR
   Xnone

   NEPA
   -Categorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   Xnone

   If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      Not Applicable

   b) If the CEQA/NEPA document has been completed, please list document name(s):

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

Conditional use permit

Variance

Subdivision Map Act

Grading Permit

General Plan Amendment

Specific Plan Approval

Rezone

Williamson Act Contract Cancellation

Other

STATE PERMITS AND APPROVALS

Scientific Collecting Permit

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land. Agency Name: City of Napa, County of Napa	Required
Permission to access state land. Agency Name: Department of Fish and Game	Required
Permission to access federal land. Agency Name: National Fish and Wildlife Service	Required
Permission to access private land. Landowner Name:	Required

6. **Comments.**

Question 5: Although the criteria for selection of sampling locations has been designed and presented in the proposal, the exact sampling locations will be determined through local input and a peer review process at the beginning of the project. Therefore, there is potential for requiring permission to access public or private lands but we cannot state yet, which landowners agencies may be approached. The study design is such that denial of access will cause reselection of sampling locations and unlikely affect the deliverables of the project.

Land Use Checklist

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   Yes

3. **Do the actions in the proposal involve physical changes in the land use?**

   No

   If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

   The project actions are research only. We will sample water and sediment at many locations in tributaries and the mainstem of the Napa River Watershed and on the margins of San Pablo Bay and Suisun Bay in order to determine the sources and magnitude of mercury loads from the Napa River Watershed, and the fate and transformation of those loads in the receiving water body. In doing so we will refine the mass balance model for the northern bays of San Francisco Estuary and develop a management model (tool) for reducing mercury methylation.

4. **Comments.**

   Question 2: Although the criteria for selection of sampling locations has been designed and presented in the proposal, the exact sampling locations will be determined through local input and a peer review process at the beginning of the project. Therefore, there is potential for requiring permission to access public or private lands but we cannot state yet, which landowners agencies may be approached. The study design is such that denial of access will cause reselection of sampling locations and unlikely affect the deliverables of the project.

Conflict of Interest Checklist

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Please list below the full names and organizations of all individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.
- Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Lester McKee, San Francisco Estuary Institute
Bruce Thompson, San Francisco Estuary Institute
Donald Yee, San Francisco Estuary Institute
Jon Leatherbarrow, San Francisco Estuary Institute
Ben Greenfield, San Francisco Estuary Institute
Lynne Curry, San Francisco Estuary Institute
Frank Leung, San Francisco Estuary Institute
Khalil Abu-Saba, Applied Marine Sciences
Andy Gunther, Applied Marine Sciences
Russ Flegal, University of California Santa Cruz

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

If yes, please list the name(s) and organization(s):

Khalil Abu-Saba	Applied Marine Sciences
Russ Flegal	University of California Santa Cruz
Mike Webster	USGS

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

Dyan Whyte SF Regional Water Quality Control Board

Comments:

Budget Summary

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1a	Spatial sampling location selection	80	2625.00	489.30						3114.3	4765.19	7879.49
1a	Spatial sampling location selection	80	1662.36	309.86						1972.22	3017.70	4989.92
1b	Spatial sample collection	120	3937.5	733.95	621.00					5292.45	7147.79	12440.24
1b	Spatial sample collection	120	2493.54	464.8						2958.34	4526.55	7484.89
1c	Spatial sample lab analysis						39900.00			39900.0		39900.00
1d	Spatial data interpretation	60	1968.75	366.98						2335.73	3573.89	5909.62
2a	OBS probe installation and maintenance	36	1181.25	220.19	138.00	2600.00				4139.44	2144.34	6283.78
2a	OBS probe installation and maintenance	84	1745.48	325.36	345.00					2415.84	3168.58	5584.42
2b	Water sample collection	200	6562.5	1223.25	690					8475.75	11915.98	20391.73
2b	Water sample collection	200								0.0		0.00
2c	Load sample lab analysis						56000			56000.0		56000.00
3a	Slough sample location selection						6084			6084.0		6084.00
3b	Slough sample collection						111591			111591.0		111591.00
3c	Slough sample analysis						31200			31200.0		31200.00
4a	Coordinating and managing QA Program	100	3198.3	596.16						3794.46	5805.91	9600.37

7a	Quarterly reports	16	525	97.86						622.86	953.04	1575.90
7b	Annual project reports	40	1312.5	244.65						1557.15	2382.6	3939.75
7c	Internal and external coordination	60	1968.75	366.98						2335.73	3573.89	5909.62
7d	Subcontracting and fiscal management	96	2326.46	433.65						2760.11	4223.25	6983.36
7d	Subcontracting and fiscal management	24	539.28	100.52						639.8	978.96	1618.76
		1316	32046.67	5973.51	1794.00	2600.00	244775.00	0.00	0.00	287189.18	58177.67	345366.85

Year 2													
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1a	Spatial sampling location selection									0.0		0.00
1b	Spatial sample collection									0.0		0.00
1d	Spatial data interpretation	20	689.06	128.44						817.5	1250.86	2068.36
2a	OBS probe maintenance	26	895.78	166.97	103.5	2400				3566.25	1626.12	5192.37
2a	OBS probe maintenance	74	1614.57	300.96						1915.53	2930.94	4846.47
3b	Slough sample collection						113191			113191.0		113191.00
3c	Slough sample analysis						31200			31200.0		31200.00
4a	Coordinating and managing QA Program	100	3358.22	625.97						3984.19	6096.2	10080.39
7a	Quarterly reports	16	551.25	102.75						654.0	1000.69	1654.69
7c	Annual project reports	60	2067.19	385.32						2452.51	3752.59	6205.10
7d	Internal and external coordination	96	2442.79	455.34						2898.13	4434.42	7332.55
7d	Subcontracting and fiscal management	24	566.24	105.55						671.79	1027.91	1699.70
		416	12185.10	2271.30	103.50	2400.00	144391.00	0.00	0.00	161350.90	22119.73	183470.63

Year 3												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
2a	OBS probe maintenance	26	940.57	175.32						1115.89	1707.43	2823.32
2a	OBS probe maintenance	74	1695.3	316	310.5					2321.8	3077.49	5399.29
2d	Loads calculation	40	1447.03	269.73						1716.76	2626.81	4343.57
2e	Loads interpretation	40	1447.03	269.73						1716.76	2626.81	4343.57
3c	Slough sample analysis						31200			31200.0		31200.00
3d	Slough data interpretation and reporting						37455			37455.0		37455.00
4a	Coordinating and managing QA Program	100	3526.13	657.27						4183.4	6401.01	10584.41
5a	Draft report	300	10852.73	2022.95						12875.68	19701.08	32576.76
5b	Peer-review coordination	20	977.96	182.29						1160.25	1775.3	2935.55
5c	Final report	40	1447.03	269.73						1716.76	2626.81	4343.57
6a	Web site	40	937.21	174.7						1111.91	1701.33	2813.24
6b	Oral presentation	40	1447.03	269.73	103.5					1820.26	2626.81	4447.07
7a	Quarterly reports	16	578.81	107.89						686.7	1050.72	1737.42
7b	Annual project reports	40	1447.03	269.73						1716.76	2626.81	4343.57
7c	Internal and external coordination	60	2170.55	404.59						2575.14	3940.22	6515.36
7d	Subcontracting and fiscal management	96	2564.93	478.1						3043.03	4656.14	7699.17
7d	Subcontracting and fiscal management	24	594.56	110.83						705.39	1079.3	1784.69
		956	32073.90	5978.59	414.00	0.00	68655.00	0.00	0.00	107121.49	58224.07	165345.56

Grand Total=<u>694183.04</u>

Comments.

Budget Justification

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Direct Labor Hours. Provide estimated hours proposed for each individual.

Lester McKee 1376 hours Bruce Thompson 20 hours Donald Yee 300 hours Jon Leatherbarrow 632 hours Lynne Curry 288 hours Patricia Chambers 40 hours Frank Leung 72 hours Khalil Abu-Saba 1160 hours Mike Webster 32 hours

Salary. Provide estimated rate of compensation proposed for each individual.

Rate of compensation for year 2 and year 3 assumes a 5% increase in salary for each person for each incremental year. Year 1, Frank Leung, $22.47 Jon Leatherbarrow, $20.78 Don Yee, $31.98 Lester McKee, $32.81 Patricia Chambers, $21.25 Bruce Thompson, $44.35 Year 2, Frank Leung, $23.59 Jon Leatherbarrow, $21.82 Don Yee, $33.58 Lester McKee, $34.45 Patricia Chambers, $22.31 Bruce Thompson, $46.57 Year 3, Frank Leung, $24.77 Jon Leatherbarrow, $22.91 Don Yee, $35.26 Lester McKee, $34.45 Patricia Chambers, $23.43 Bruce Thompson, $48.90

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

San Francisco Estuary Institute provides benefits to all of its employees at a rate of 18.64% Applied Marine Science provides benefits to all of its employees at a rate of 19.34%

Travel. Provide purpose and estimate costs for all non-local travel.

All our travel is local

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

N/a

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

Task 2a: OBS probe installation and maintenance Mike Webster and staff USGS Year 1: Labor: 32 hours = $842.69, Travel =$120, Supplies and contingency = $378.13, Hotel and podium = $340, Overhead support services = $1700.69, TOTAL = $3401.38 Travel = $60/day x 2 days; hotel and podium is for 2 people for 2 days and 1 night Task 3A: Slough sampling design Khalil Abu-Saba and staff Applied Marine Sciences Year 1: Labor (60 hours) - $5,100; Travel - $570; Services - $414; TOTAL - $6084 Labor includes Khalil Abu-Saba at 67%, Associate Scientist at 33% Travel funds for attendance of stakeholder workgroups Services funds are for reproduction and general overhead. Task 3B and 3C: Slough sampling and analysis Khalil Abu-Saba and staff Applied Marine Sciences Year 1: Labor (400 hours) - $32,000; Travel - $6,440; Supplies - $1,000; Services - $72,151; TOTAL - $111,591 Year 2: Labor (400 hours) - $33,600; Travel - $6,440; Supplies - $1,000; Services - $72,151; TOTAL - $113,191 Labor includes Senior Scientist at 50%, Associate Scientist at 50% Travel includes sample collection and per diem Supplies include general field supplies to support sample collections. Services funds are for analytical chemistry, subcontractor to be determined, as well as general overhead. Task 3D: Data interpretation and reporting Khalil Abu-Saba and staff Applied Marine Sciences Year 3: Labor (300 hours) - $15,750; Travel - $4,576; Services - $1,379; TOTAL - $37,455 Labor includes Khalil Abu-Saba at 100% Travel includes 1 trip to Sacramento and 1 trip to National conference Services includes reproduction and general overhead Task 1c, Cost per sample Container preparation, $50.00 Methylmercury, $150.00 Total mercury, $150.00 Total organic carbon, $100.00 Near-total Trace metals (aluminum, silver, manganese, copper, nickel, chromium, nickel, zinc), $200.00 % Fines (<63 μm after peroxide digestion), $300.00 Total per sample cost, $950.00 Number of stations, 35 Number of times sampled, 1 Replicate samples, 7 Total number of samples, 42 Total Analytical costs, $39,900.00 , Task 2c, Cost per sample Container preparation, $50.00 Total mercury, $150.00 Total suspended solids, $50.00 Nutrients (silicates, nitrate, nitrite, ammonia, phosphate), $150.00 Particle size distribution, $300.00 Total per sample cost, $700.00 Number of stations, 40 Number of times sampled, 2 Replicate samples, 0 Total number of samples, 80 Total Analytical costs, $56,000.00 , Task 3c, Cost per sample Container preparation, $50.00 Unfiltered total mercury, $150.00 Unfiltered methylmercury, $150.00 Suspended load, $50.00 Total organic carbon, $100.00 Nutrients (silicates, nitrate, nitrite, ammonia, phosphate), $150.00 Total per sample cost, $650.00 Number of stations, 15 Number of times sampled, 8 Replicate samples, 24 Total number of samples, 144 Total Analytical costs, $93,600.00

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

Task 2a: Two Optical Backscatter (OBS) probes will be perchased from D and A Instrument Company 40-A Seton Road, Port Townsend, WA 98368. OBS-3 probe cost per unit $1800 + current loop transmitter $230 + cable $200 Total cost for two OBS-3 units = $4460

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

Annual project reports, 120h, $4,137.66 Internal and external coordination, 180h, $6,206.48 Quarterly reports, 48h, $1,655.06 Subcontracting and fiscal management, 360h, $9,034.26

Other Direct Costs. Provide any other direct costs not already covered.

We have not included any other dirrect costs

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

SFEI's indirect costs include: Rent on buildings, telephone, general office supplies, copy machine lease etc. plus administrative time that time cannot be charged back to a funded project, holiday, vacation and sick time.

Executive Summary

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

This study addresses basic science gaps related to mercury loading and methylation in the CALFED Bay-Delta area. The study area is the Napa River watershed and sloughs along the margins of Suisun Bay and San Pablo Bay. In the first phase, sample locations are selected to meet project criteria in coordination with stakeholders and a science review team. In the second phase, discreet sediment and water samples will be collected throughout the Napa River watershed, a continuous monitoring device will be installed to measure suspended load at the USGS Napa River gauging station, and sloughs will be sampled for methylmercury, total mercury, salinity, and dissolved oxygen (DO). In the third phase, the data will be synthesized, peer-reviewed, and reported to stakeholders and CALFED. The abbreviated hypotheses of the project are: H10 : Loads associated with historic mining in the Napa River watershed dominate the internal load to the northern reach of San Francisco Bay. H20: The average concentration of mercury in sediments exported from the Napa River watershed is relatively constant. H30: Methylation efficiency is independent of salinity. H40: Dissolved oxygen and salinity are poor predictors of methylation efficiency in the Bay. The key expected outcomes are i) improved recommendations for management of mercury in San Pablo and Suisun Bays through the refinement of the mercury mass balance; and ii) development of a reliable predictive numerical model to relate management actions (i.e., water reclamation projects, regulation of DO) to mercury methylation. This project addresses a number of CALFED ERP objectives including i) the assessment of the adverse ecological effects of DO depletion because of mercury methylation and consequent transfer into the food web; ii) the source, transport, and transformation of sediment-related contaminant loads; and iii) key processes affecting the beneficial uses of fishing and wildlife habitat.

Proposal

San Francisco Estuary Institute

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Lester McKee, San Francisco Estuary Institute
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Russ Flegal, University of California Santa Cruz

Mercury Watershed Loads and Bayland Methylation Processes in the Northern Reach of San Francisco Bay: Linking Basic Science, Water Quality Standards, and Management Actions in the CALFED Bay-Delta area.

Lester McKee (San Francisco Estuary Institute) & Khalil Abu-Saba (Applied Marine Sciences)

A. Project Description: Project Goals and Scope of Work

Goals: To fill basic science gaps related to mercury loading and methylation, define linkages to existing water quality regulations, and identify whether new regulations or guidance documents are needed to guide management actions in the CALFED Bay-Delta area.

Scope of work: The work is a monitoring and research project that addresses two study areas: the Napa River watershed and a transect of wetlands and sloughs (the Baylands) from Suisun Bay to San Pablo Bay. The work will proceed in three phases. In the first phase the project team will work with local resource conservation districts and stormwater managers to gain access to sampling locations within the Napa River watershed and in the Baylands. The team will integrate monitoring data and geographic information and conduct stakeholder meetings to explain the project goals and request land and water access, and then have the resulting sampling plan reviewed by a science panel. In the second phase, the project team will establish continuous monitoring sites for suspended loads and collect discreet sediment and water samples for total mercury and methyl mercury analysis in the Napa River Watershed and in the Baylands. The second phase will last two and one half years (three wet seasons), and conduct sampling during both wet and dry seasons. The third phase will synthesize and integrate the findings, have them reviewed by a science panel, and then present them in a stakeholder forum.

1. Problem

Management actions in the CALFED Bay-Delta area should be guided by basic science, and enacted through regulation and public process. Decisions about watershed restorations flow management, water reclamation, and wetland creation and enhancement projects should consider the science needed to define protection and attainment of beneficial uses (e.g., fishing, wildlife habitat), and then relate that science information to existing or needed regulations.
Risk assessment guidance for protection of human health indicates that there is too much mercury in popular species of sport fish caught from San Francisco Bay (Figure 1). Mercury is a potent developmental neurotoxin. The principal exposure route is through consumption of contaminated fish. At high concentrations, mercury exposure through the food chain can cause severe birth defects and infant mortality, as was observed in the tragedy of Minamata Bay, Japan in the 1950’s. At lower concentrations, the concern is over the long-term health of people that regularly eat fish, especially children and women of childbearing age. The most recent risk assessment by the National Academy of Sciences indicates that regular consumption of fish with mercury concentrations similar to those found in San Francisco Bay can lead to impaired development of hearing and fine motor skills in young children.

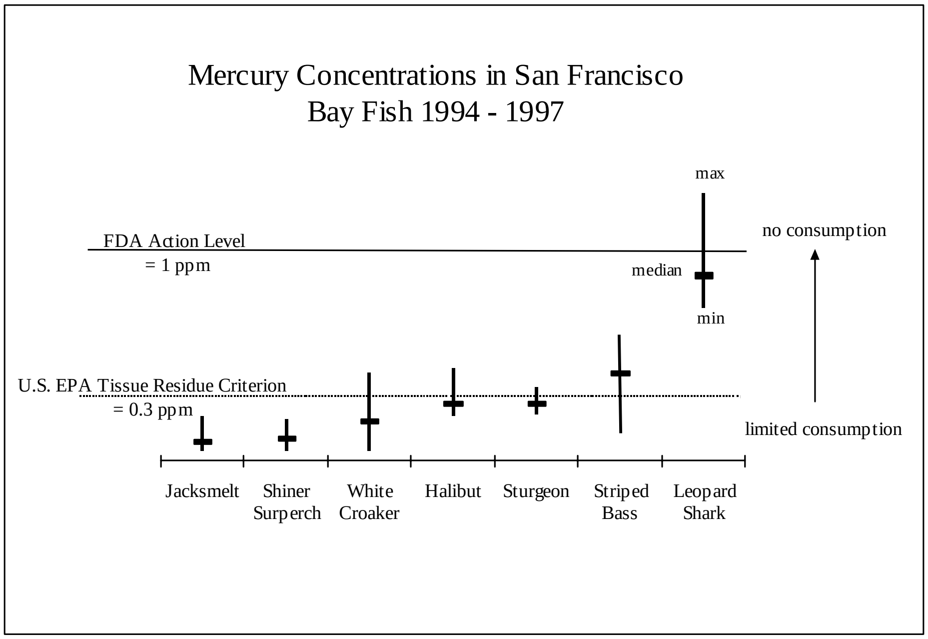


Figure 1: Mercury concentrations (ppm wet weight) in fish caught from San Francisco Bay, 1994-1997. These data are from the San Francisco Bay Regional Monitoring Program (Davis et al, 2000).

The beneficial use of fishing is enjoyed by millions of people. Statewide sales of sport fishing licenses and stamps generated more than $48 million in revenue for the California Department of Fish and Game in 2000, when more than 2.2 million anglers purchased some type of California fishing license (CDFG 2001). Scaling that to the number of people living close enough to San Francisco Bay to consider it a fishing resource, and considering consumption habits around the Bay (SFEI, 2000), mercury regulation affects 100,000 – 300,000 people who fish the Bay for food. This includes thousands of pregnant women and tens of thousands of children and women of childbearing age.

Since there is too much mercury in fish for unlimited consumption by humans who get *some* of their protein from the Bay, then there is too much mercury in fish for consumption by wildlife that get *all* of their protein from the Bay. The United States Fish and Wildlife Service indicates that bird eggs in San Francisco Bay have consistently higher mercury concentrations than eggs from the same species in other regions of the country. Mercury concentrations in eggs occur at concentrations high enough to account for anomalously high egg failure rates. This has potential impacts on endangered wildlife, such as the California Clapper Rail and the California Least Tern. Consequently, the beneficial uses of wildlife habitat and protection of rare and endangered species are not attained due to mercury impairment (Schwarzbach and Adelsbach, 2001).

CALFED projects to restore fish populations will also need to consider ways to improve the quality of fish as food for people and wildlife. Management information is needed to evaluate where projects can most effectively reduce mercury levels in fish, and what project design features for restored wetlands best minimize bioaccumulation. Two critical information gaps have been identified by recent studies. One information gap is the source of mercury loadings to the Bay-Delta between Suisun Bay and San Pablo Bay. The other information gap is the degree to which existing regulations guide management choices affecting mercury methylation and bioaccumulation.

The San Francisco Bay Regional Water Quality Control Board (The Regional Board) developed a mercury mass balance for mercury in San Francisco Bay as part of a Total Maximum Daily Load (TMDL) (Abu-Saba and Tang, 2000). That analysis demonstrated an internal load (i.e., downstream of the Sacramento San Joaquin River Delta) of 200-500 kg mercury within the northern reach of San Francisco Bay. Considering all possible sources, the two largest potential contributors are historically polluted sediments within the Bay and watershed sources outside the Bay. This study will investigate the Napa River watershed, because it is the largest single watershed source of flow and sediments downstream of the Delta, and it contains known mercury mines and mercury-bearing mineral formations.

A recent regional collaborative study conducted by Bay Area stormwater agencies (Gunther et al., 2001; Kinnetic Laboratories Inc. 2001) surveyed bioaccumulative pollutants in urban and non-urban creeks and stormwater conveyances. Significantly greater concentrations of mercury and PCBs were found in sediments from urban sites compared to non-urban sites. Other studies have linked significant mercury loads to violation of water quality objectives downstream of mercury mining waste (Abu-Saba and Tang, 2000; Ganguli et al, 2000; Whyte and Kirchner, 2000). However, little information is available from the Napa watershed. The size of that watershed, the presence of natural geological sources, a historic and continually developing agricultural industry, and the history of mining suggests that it may be a significant source of mercury, nutrients, and other pollutants.

The San Francisco Bay Basin Regional Water Quality Control Plan (the Basin Plan) identifies several mercury mines in the Napa River watershed, including the La Joya, Hastings, St. Johns, and Borges mines. Some of the mercury deposits in the Napa River watershed are likely from the same ore-body as deposits located within the Central Valley Regional Water Quality Control Board's jurisdiction, with only a ridge-top separating the watersheds [Dyan Whyte, pers. Communication]. So the Napa River watershed is also interesting to study because of its regional and geological significance to the question of mercury loads from mining legacies.

During the latter part of the nineteenth century, mercury was mined extensively along the coast range, mainly for refining gold during the Central Valley Gold Rush. During and after the hydraulic mining era, the sediment supply to central Valley streams is thought to have increased by about 5 times (Kondolf, 2000) leading to the transport and deposition of large volumes of mercury laden sediment in the Delta and San Francisco Bay. Much of this sediment may have been stored in the marginal wetlands and mudflats, especially those adjacent to Suisun and San Pablo Bay. Over the past 50 years San Pablo Bay has been in a state of net erosion (Jaffe et al., 1996) likely caused by a decrease in sediment load entering San Francisco Bay from the Central Valley (McKee and Schoellhamer, in review). The process of sediment deposition, reworking, resuspension, and net erosion acts as a long-term, internal load of mercury to the Bay-Delta.

An outstanding issue is the contribution of potentially controllable sources (e.g. mines subject to remediation) relative to uncontrollable sources (e.g. exposure of legacy sediments). The CALFED Bay-Delta Mercury Project addresses mercury loads from the Central Valley Region (Foe, 2001; Domagalksi and Alpers, 2001). The Regional Board has accurately quantified anthropogenic loads through its compliance monitoring programs for wastewater and urban runoff permits (Abu-Saba and Tang, 2000; Gunther et al 2001). The Regional Monitoring

Program has accurately measured mercury atmospheric deposition rates in the Bay Area (Tsai et al 2001). Compliance monitoring has identified legacy sources in the Guadalupe River watershed in Lower South Bay, as well as the Marsh creek watershed in Contra Costa County.

The part we still need to better understand is how much of the 150 - 600 kg excess observed in the northern reach of San Francisco Bay comes from exposure of legacy sediments, and how much comes from upland watersheds. This study will quantify the latter part, focusing on the Napa River watershed. The conceptual model for the study frames the question in a way that can help infer the internal remobilization load by difference. Subsequent modeling and monitoring studies, though beyond the scope of this proposal, can help verify the inferred internal loads due to remobilization, and predict how those loads might change over time.

The CALFED Bay-Delta Mercury Project has also provided important preliminary information on methylation. A potential hot spot for mercury accumulation in Cormorant eggs was identified in Suisun Bay (Schwarzbach and Adelsbach, 2001). A preliminary assessment of mercury methylation (Figure 2 provides compelling, explainable evidence that there is a link between dissolved oxygen and methylation efficiency in this region. Suisun marsh is known to have low dissolved oxygen, especially during the late summer and early fall. This may have significant effects on the production and release of methylmercury, the most bioaccumulative form of mercury.

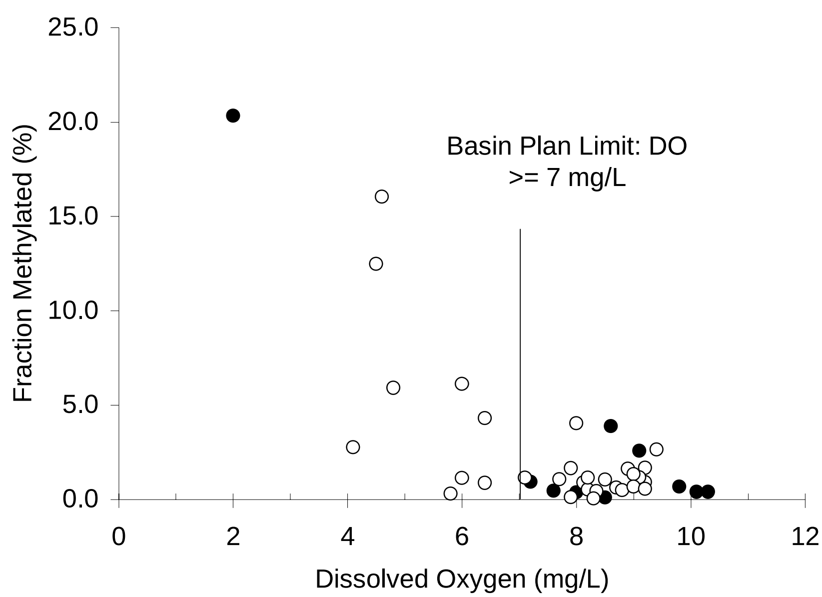


Figure 2: Methylmercury-Total mercury ratios vs. dissolved oxygen in unfiltered water samples collected from Suisun Bay sloughs, in the northern reach of San Francisco Bay, August 2000 – May 2001. Open circles indicate receiving waters subject to tertiary treated discharge, filled circles indicate reference sloughs. Vertical line indicates the minimum DO levels required in the Basin Plan. Draft data provide courtesy of Fairfield-Suisun Sewer District.

This is potentially important management information. There are potential regulatory controls on anthropogenic processes that cause low dissolved oxygen. Many of the wetlands and marshes around Suisun Bay are managed as duck clubs and wetland restoration projects; others have been diked for agricultural use. There may be ways to manage flow, inundation, and other physical factors to maximize dissolved oxygen, and thereby minimize the production and release of methylmercury.

2. Justification
a. Conceptual model

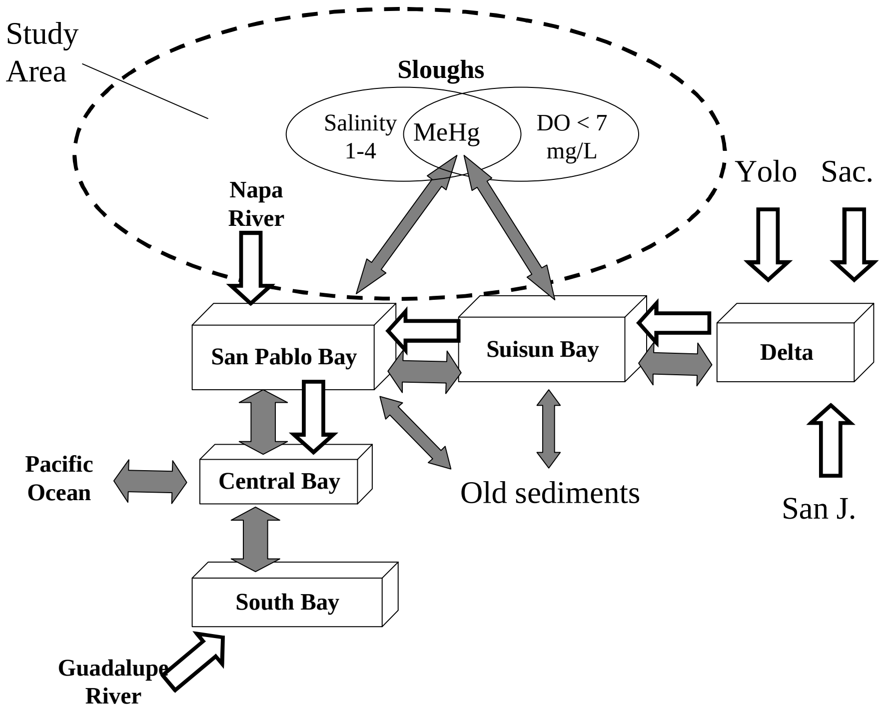
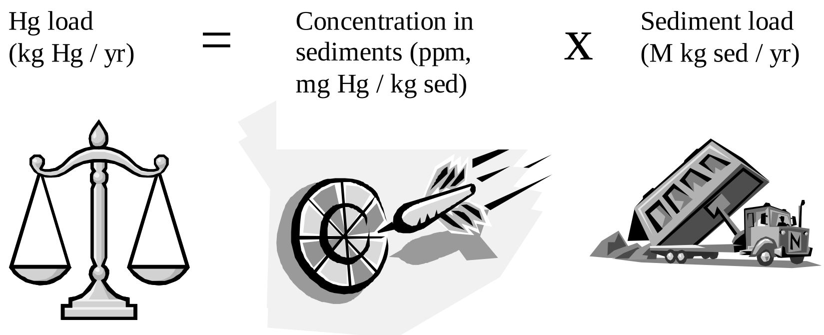


Figure 3: Conceptual model for mercury loading and methylation in the San Francisco Bay Estuary. Light single arrows indicate river transport; dark double arrows indicate mixing by wind and tides (for adjacent water bodies) or mixing by resuspension and reworking (for old sediments).

For the hypotheses in this study, the mercury cycle in San Francisco Bay can be conceptualized as the coupled processes of transport and transformation (Figure 3. Mercury enters the hydrographically distinct northern and southern reaches of the Bay from two different watersheds. The Guadalupe River is in a relatively small South Bay watershed that drains the New Almaden mining district, which was at one time the largest producer of mercury in North America. The Sacramento and San Joaquin River watersheds together drain 37% of the land area in California, and are impacted by many smaller mercury and gold mining operations; atmospheric deposition may also play a significant role because of the relatively large area of the Central Valley. Thus, although absolute loads from the Delta are higher (200-800 kg) than loads to the South Bay (20-100 kg), mercury concentrations in sediments increase to the south because South Bay water and sediment residence times are longer.

Mercury loadings are quantified by considering mercury concentrations in sediments and sediment transport rates, using Equation 1.



Equation 1: Relationship between mercury loads, mercury concentrations in sediments, and sediment load.

Advective loadings (white single arrows), such as watershed loads are modeled as:

$$W\ (kg/yr) = ([Hg]_{sediment})\ x\ (\Phi_{sediment}),$$

i.e., the expected mercury concentration in sediments (mg mercury per kg of sediment) times the sediment flux (M kg sediment per year). Net loads due to mixing between compartments (dark double arrows), such as erosional remobilization of old sediments, are modeled (using the same notation) as:

$$R\ (kg/yr) = ([Hg]_{sediment,in})\ x\ (\Phi_{sediment,in}) - ([Hg]_{sediment,in})\ x\ (\Phi_{sediment,in}).$$

The advantage to describing the mercury mass balance in terms of mercury concentrations in sediments is that reliable, readily available measurements can be used to estimate loads.

The average concentration of mercury in sediments transported from the Delta is 0.2 ppm (Abu-Saba and Tang, 2000). This may increase to as much as 0.5 ppm during high-flow periods as a result of either enhanced export from mining sources or increased scouring under high-energy flows. Given an export of 3,000 - 4,000 M kg of sediment per year from the Central Valley, this corresponds to a load of 200 - 800 kg.

Mercury concentrations in sediments increase to 0.25 - 0.35 ppm between the Delta and San Pablo Bay. This implies that the net effect of all the complex mixing and advective processes between the Delta and San Pablo Bays is an internal loading between 150 and 600 kg per year. Monitoring data confirms that wastewater discharges only account for a small fraction of this internal load (<15 kg) (Abu-Saba and Tang, 2000).

Monitoring data from urban runoff conveyances also suggest a relatively small contribution (~20 kg). Atmospheric deposition measurements show that direct deposition accounts for possibly another 20 kg (indirect deposition is incorporated in the urban runoff estimate). Therefore, the 150 - 600 kg mercury input observed in the northern reach is likely dominated by a combination of local watershed inputs and remobilization of old sediments:

Equation 2: **I (kg/yr) = W + R**

Other watersheds (e.g. Walker Creek in Tomales Bay, the Guadalupe River in South Bay) draining mercury mines have substantial, seasonally variable mercury loads. A combination of bedded sediment sampling, discreet water column sampling, and continuous monitoring of flow and suspended load will be used to characterize the flux of mercury out of the Napa River watershed.

The question of benthic remobilization is important, but directly addressing it is beyond the scope of the current study. The USGS is currently verifying a model of the three-dimensional locations of mercury-polluted sediments (Jaffee et al. 1998). This model can be used to make some initial judgements about the potential reservoir of mercury, but accurate loads will require more sophisticated modeling. As we begin to get results through this study, we will discuss the preliminary interpretations with the USGS group and collectively develop hypotheses and refine models for the San Pablo Bay and Suisun Bay.

In this study, we approach the problem by treating the internal load (I) as a known quantity (150-600 kg/yr), and seek to quantify a potentially significant watershed load (W). This will help us define the boundaries of the remobilization load (R).

Complex biogeochemical processes drive the observed increase in methylation efficiency under sub-oxic conditions in Suisun Marsh. Neutrally charged complexes of inorganic mercury are formed in fresh-brackish waters; these complexes are more readily taken up by methylating bacteria than charged complexes (Benoit et al., 1999; Gilmour et al., 1992). Low dissolved oxygen can is both a direct cause (methylating bacteria thrive under anoxic conditions) and a marker for inputs from anoxic wetlands and marshes. Low dissolved oxygen can also facilitate the release of methylmercury through dissolution of oxyhydroxide surfaces. The highest rate of methylmercury release is predicted to occur in fresh-brackish water bodies with low dissolved oxygen.

Mercury in sediments of the Bay and its watersheds is converted to methylmercury when the sediments enter in anoxic regions, where the methylation rates of sulfate reducing bacteria can outstrip the biotic and abiotic demethylation processes. Recent findings of the CALFED Mercury Group show that methylation efficiency is highest along the margins of the Bay (Stephenson and Cole, 2001). Likewise, methylation efficiency in sediments increases moving from main channels to primary, secondary and tertiary sloughs (Schwarzbach et al, 2000). So our model for methylmercury production in the Bay has a strong source term that involves methylation in the margins coupled with mixing/advection to the interior. A quantitative, explainable relationship between readily measurable physical parameters (temperature, salinity, suspended load, dissolved oxygen) will help future efforts to develop and calibrate a mass balance model for methylmercury in the Bay.

b. Relationship to adaptive management model in the Implementation Plan

The two goals of this study support the management model for mercury shown in Figure 4) The Napa River watershed assessment focuses on loads (the vertical axis). The northern Baylands assessment focuses on methylation efficiency (the horizontal axis). To reduce mercury concentrations in upper trophic levels, we will need to take actions that reduce loads. But it will likely take many decades to realize the benefit of load reductions, because of the relatively long residence time of mercury in the Bay. Actions that decrease methylation efficiency could provide more immediate, short-term benefits.

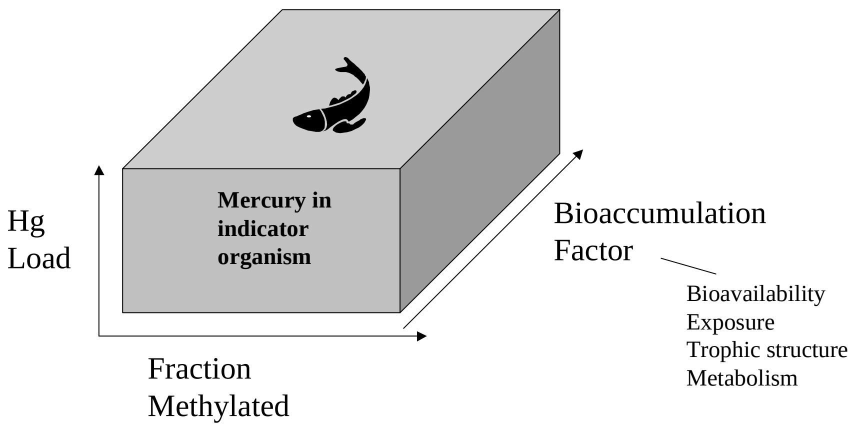


Figure 4: Concentration of mercury in fish (volume of the box) is the product of loading rate (vertical axis), fraction methylated (horizontal axis), and the methylmercury bioaccumulation factor (depth axis).

c. Overall Hypotheses

$H1_0$: Loads associated with historic mining in the Napa River watershed dominate the internal load to the northern reach of San Francisco Bay.

$H1_a$: Loads associated with remobilization of legacy sediments dominate the internal load to the northern reach of San Francisco Bay.

$H2_0$: The average concentration of mercury in sediments exported from the Napa River watershed is relatively constant.

$H2_a$: The average concentration of mercury in sediments exported from the Napa River watershed is seasonally variable, as with other mining-impacted watersheds.

$H3_0$: Methylation efficiency is independent of salinity.

$H3_a$: Methylation efficiency (as characterized by the fraction methylated) is highest in brackish waters.

$H4_0$: Dissolved oxygen and salinity are poor predictors of methylation efficiency in the Bay.

$H4_{a1}$: Dissolved oxygen and salinity are good geographically and seasonally specific predictors of methylation efficiency in the Bay.

$H4_{a2}$: Dissolved oxygen and salinity are good general predictors of methylation efficiency in the Bay.

d. Project type

The project proposed is a ***targeted research project*** designed to inform future decisions about watershed restoration and Bayland management. There is currently a lack of scientific certainty as to the dominant source of internal loadings to San Francisco Bay. Before watershed restorations of inoperative mines in the Napa River watershed are initiated, we need some estimate of how their loadings compare to other processes. Likewise, though preliminary data linking dissolved oxygen to methylation efficiency suggest

3. Approach

Task 1 Watershed Sampling for Sources of Mercury

This task will determine spatial trends in the concentration of mercury in sediments from depositional areas in the tributaries of the Napa River watershed. Sampling and analysis is designed to identify influences of lithology, mining, and other land use practices.

Phase 1

Task 1a Spatial sampling location selection: Napa River Watershed has nine lithological types that cover areas of large enough size to allow discrete sampling in watershed streams. We will select a subset of sub-watersheds where each of the nine lithologies are known to be dominant based on USGS geological maps. We will aim to sample each lithological type in two locations of varying hydrological character (basically upper watershed high rainfall and lower watershed lower rainfall) making a total of 18 locations. There are at least four inoperative mercury mine sites in the Napa River watershed, as identified in the Basin Plan. We will sample in areas immediately downstream of these locations to determine if there is an impact associated with mining. Additionally we will sample in the lower parts of the sub-watersheds where there was mining to determine the extent of any contamination. In total there will be 12 mine-related samples. Lastly we will sample the mainstem of the Napa River watershed from the head waters down to the confluence with Carneros Creek in the tidal area taking into account the potential influence of the small towns of Saint Helena, Yountville, the City of Napa, and the confluence of creeks with a range of lithologies and mining influences in order to characterize down stream accumulative effects making up another five locations. In total there will be 35 locations sampled. Whenever the preferred locations for sampling are on private property, landowners will be contacted for permission to access the creek. In most cases access from roads or bridges will reduce the need to access private property. Parcel maps will be used to determine when access is required. A combination stakeholder group meetings and a mail out for permission along with consultation with local groups such as the Napa RCD and the NRCS will occur. A field reconnaissance will allow a final selection of sampling sites, which will be reviewed by a science team.

Phase 2

Task 1b Spatial sample collection: At each sampling location, sediments will be collected from the toe of depositional beds from several spots in the stream using Kynar™-coated scoops. The upper 2-3 cm will be sampled, avoiding areas where it appears sediments are derived mainly from sources such as bank slumping. Loss of fine material during sampling will be avoided to the maximum extent practicable. Field notes will include observations of temperature and dissolved oxygen in overlying waters.

Task 1c Spatial sample lab analysis: Sediments will be analyzed for:

- Methylmercury
- Total mercury
- Total organic carbon

Near-total Trace metals (aluminum, silver, manganese, copper, nickel, chromium, nickel, zinc)

% Fines (<63 µm after peroxide digestion)

Archive samples will be retained for up to three years in case additional analysis (i.e. lead isotopes, leachable trace metals) is needed.

Phase 3

Task 1d Spatial data interpretation: Multivariate analysis can help characterize the variation between lithologies and between mining and non-mining areas in the Napa River watershed. Accessory trace metals can help unravel other watershed processes (e.g., chromium and nickel are good tracers for Franciscan formation ultramafic minerals). Gradients in sediment concentrations can help identify upland sources of mercury. Qualitative and statistical comparisons will also be carried out with other existing data sets, for example, Gunther et al., 2001; Kinnetic Laboratories Inc. 2001 and data from work at Marsh Creek, New Idria, and Cache Creek, and the Guadalupe River to place the Napa River data in a regional context.

Task 2 Determination of Watershed Loads

Introduction

In order to estimate contaminant loads with accuracy and precision, a sampling strategy will be used that characterizes contaminant concentrations during short-lived storm events when at least 80% of the annual loads are transported on an annual basis. Even when this is completed for one year, inter-annual variations associated with climate make it difficult to extrapolate results to other years and estimate the variability and average loads entering the Bay from a small tributary. To get around this problem, continuous monitoring of a surrogate water quality parameter (such as optical back scatter) can be used to extrapolate between empirical water quality data points at times when there are no data. Optical Back-scatter (OBS) or turbidity has been widely used as a surrogate variable to predict suspended sediment concentration (e.g. Walling et al. 1997) and has been used locally with success in a watershed tributary to Tomales Bay for estimation of Mercury concentration (Whyte and Kirchner, 2000). Although there is discussion on the applicability of this methodology in some California streams (e.g. ref), assessment of grainsize characteristics in the Napa River (Palmer et al. 1990) suggest about 90% of the suspended sediment is <0.062 mm during flood months and therefore the method is applicable.

Phase 2

Task 2a OBS probe installation and maintenance: An optical backscatter (OBS) probe will be purchased, installed and maintained on the Napa River in Napa at the USGS gauge (location 11458000). We have discussed with USGS the potential for collaboration on the installation. The probe will be installed for three consecutive wet seasons from November 1st to April 30th. The instrument will be retrieved from the field every three weeks for cleaning, calibration, downloading data, and battery replacement.

Task 2b Water sample collection: Measurement of loads will begin at on the Napa River at Napa (USGS gauge location 11458000) in the first wet season (November 2002) and continue for three wet seasons. We will collect no less than 30 water samples during flood in the first wet season. If the winter is relatively dry, sampling will continue during the 2003/2004 wet season until a sample size of at least 30 samples has been collected. An analysis of existing discharge data for the Napa River suggests that the odds of two drought years (years with <0.9MAR) in a row is 20%.

Task 2c Load sample lab analysis: Water samples will be analyzed for:

Total mercury
Total suspended solids
Nutrients (silicates, TN, TP, nitrate, nitrite, ammonia, phosphate)
Particle size distribution

Phase 3

Task 2d Loads calculation: Regression models will be developed using mercury concentration and suspended load for discrete samples, to determine how the concentration of mercury in suspended particles responds to flow (Hypothesis 2). A calibration curve between suspended load and OBS data will be developed. With those two pieces, reasonable estimates for annual mercury fluxes can be calculated following methods outlined by the USGS (Buchanan and Ruhl, 2000).

Task 2e Loads interpretation: Loads data from the Napa River would be interpreted in the context of loads from other mining watersheds such as Guadalupe, Mt Diablo (Marsh Creek), New Idria and Cache Creek. The spatial data (Task 1) will help identify to what extent load reduction from controllable sources is possible. Loads would be compared to the known internal load (150 - 600 kg /yr) to determine whether the Napa River is a significant contributor (Hypothesis 1).

<u>Task 3 Assessment of physical factors correlated with methylation efficiency in San Pablo Bay and Suisun Bay Sloughs:</u>

Phase 1

Task 3a: Slough sample location selection. Sampling locations should cover the widest possible range of slough order, salinity, and human impacts (i.e. wastewater, agricultural runoff, inflow from managed marshes). We will prepare preliminary list of sampling locations, and then notify stakeholders and interested parties to discuss the sampling plan and objectives. Within the stakeholder forum we will also request access to sampling locations, as needed. We will modify the proposed locations according to accessibility and other stakeholder recommendations. The final list of sampling locations will be reviewed by a science review team to confirm they adequately address project goals. The final list will consist of 15 sampling stations. These will be sampled four times, for a total of 60 samples per year.

Phase 2

Task 3b Slough sample collection: Samples from sloughs surrounding the northern reach will be collected in two seasons: late summer to early fall (August - October), and winter to early spring (February -April). Each station will be sampled twice per season, with roughly one to two weeks between samplings. This design attempts to capture both between-season and within-season variability. Samples will be collected from a small craft (Zodiac or Boston Whaler) using a portable peristaltic pump. Established methods will be used to prevent sample contamination during collection (Flegal et al, 1991). Field measurements will include salinity, dissolved oxygen, pH, conductivity, temperature, Sechi depth, and observations of wind, tide, current and sunlight.

Task 3c Slough sample analysis: Water samples will be analyzed for:

Unfiltered total mercury

Unfiltered methylmercury
Suspended load
Total organic carbon
Nutrients (silicates, nitrate, nitrite, ammonia, phosphate)

Phase 3
Task 3d Slough data interpretation: Slough data will be compiled and analyze to determine whether there is a peak in methylation efficiency in fresh-brackish waters (Hypothesis 3), and whether methylation efficiency is associated most strongly with low dissolved oxygen in fresh-brackish regions (hypothesis 4).

Task 4: Coordinating and managing the quality assurance Program:
Phase 2
The duties involved with this task will include:
1. Ensuring sampling and storage during field work follow predetermined protocols and procedures for clean sample collection and sample preservation
2. Confirmation that samples arrived at the lab in appropriate condition
3. Monitoring analytical progress
4. Ensuring that the lab follows its quality assurance program
5. Assessing data for anomalies and checking the lab QA records upon receipt of the data

Task 5 Reporting
Phase 3
Task 5a Draft report: A report will be written (in a pdf web ready format) that will include the following elements: 1. Abstract, 2 Table of contents, 3. Introduction, literature review, and objectives, 4. Methods, 5. Results, 6. meHg model development and testing, 7. Discussion, 8 Conclusions and recommendations, 9. Acknowledgements, and 10. References cited.

Task 5b Peer-review coordination: The completed draft will be sent to CALFED for review. SFEI's senior scientist (Bruce Thompson) will receive a list of 10 possible reviews from the Project Team. The report will be sent anomalously to two of these potential reviewers for detailed comments. Each reviewer will be paid a small podium of $200 to ensure the report if reviewed with care.

Task 5c Final report: Peer-reviewer comments incorporated before final submission to CALFED.

Task 6 Information dissemination
Phase 3
Task 6a Web site: The final report and raw data appendix will be available on the SFEI and AMS web pages.

Task 6b Oral presentation: The results will be presented to local stakeholders and managers, and regional managers in a series of oral workshops. The results will be presented orally to CALFED as requested at annual review meetings and at any subsequent CALFED science conference.

Task 7 Project management
All phases

Task 7a Quarterly reports: SFEI/AMS will submit a quarterly fiscal and programmatic report on the 10^{th} day after the close of each quarter.

Task 7b Annual project reports: SFEI/AMS will submit at the end of year 1 and year 2 a report outlining preliminary findings, progress. Data will submitted at the end of each year as a paper copy, pdf file and electronic format compatible with MS Access.

Task 7c Internal and external coordination: SFEI and AMS staff monthly meetings. Liaison with external collaborators and interested parties. Project planning and management.

Task 7d Subcontracting and fiscal management: SFEI's contracts management and accounting department will work with the Project Managers and complete all necessary duties to ensure timely contracts and fiscal reporting and invoicing.

4. Feasibility

The methods that we propose to use are founded on good science research both locally and in other parts of the world. River and estuarine sediments are ideal indicators of environmental impact because they integrate many of the effects of pollution upstream and are less subject to climatic variability. These methods are currently being used in other watersheds around the Bay for watershed characterization and prioritization of monitoring and management actions. The OBS method was also chosen to reduce the likely impact of climatic variability on data collection for the measurement of loads entering San Pablo Bay from the Napa River watershed. Existing USGS flow data for the Napa indicated that there is only a 10% chance of sampling a year during which the Napa River produces discharge within 10% of the mean. Because it is difficult to sample every flood and expensive to sample floods during multiple years, the use of the OBS probe for extrapolation between data points represents the most feasible method for estimating typical loads of mercury and other associated pollutants.

The involvement of local partners will ensure that this scientific approach to assisting in local planning is not viewed as excluding local citizens and governments partners in the decision making process. Further it will provide for an environmental education by involving local stakeholders in many phases of the project from data collection, to preliminary results, reporting and formulation and review of the outcomes and recommendations from the project.

The endorsement and support from the Region 2 San Francisco Regional Water Quality Control Board and the Region 9 EPA will ensure that the project will have the greatest potential to result in the outcomes being infused into local and regional management plans to reduce the impact of mercury in the Napa River and San Pablo Bay.

There are no permits or agreements necessary to complete the work. USGS has offered their collaboration for installing the OBS probe at the Napa gauge. Consent from local landowners to access streams is desirable and will be obtained prior to fieldwork, however, the absolute sample locations are not fixed and in most cases access can be obtained from roads and just upstream of bridges.

5. Performance Measures

Objective or product	**Appropriate indicator**	**Measurement of success (performance measures)**
Watershed spatial sample collection and lab analysis	Data report	Submitted to CALFED before Jan 2004
Slough sample collection and lab analysis	Data report	Submitted to CALFED before Jan 2005
Installation of the OBS probe	Data collection	Successful download of first 3 weeks of data
Collection of OBS data each wet season	Data report	Submitted to CALFED annually
Collection of wet season watershed water samples and lab analysis	Data report	Submitted to CALFED before Jan 2005
Lab analysis of data	Lab QA protocols in place	Lab QA report, review of data for blanks, duplicates, matrix spikes/spike duplicates surrogate spikes, lab control samples, certified reference materials, and lab replicates
Completion of watershed spatial statistical analysis	Completed tables and graphs	Quarterly and annual reports of preliminary results submitted to CALFED January 2004
Completion of spatial data interpretation	Completed tables and graphs	Quarterly and annual reports of preliminary results submitted to CALFED January 2004
Preliminary loads calculations	Completed tables and graphs	Quarterly and annual reports of preliminary results submitted to CALFED January 2004 though to project completion
Preliminary loads comparisons	Completed tables and graphs	Quarterly and annual reports of preliminary results submitted to CALFED January 2004 though to project completion
Preliminary slough data interpretation	Completed tables and graphs	Quarterly and annual reports of preliminary results submitted to CALFED January 2004 through to project completion
Completion of the draft report	Hard copy printed	Received by CALFED for review
Completion of final report	Peer review	Sent to CALFED
Web site	Announcement to interested parties	Downloadable using moderate level computing printing technology
Oral presentation	A) Announcement and completion of a local workshop, B) CALFED conference	A) Local review and use for improving management, B) Local multidisciplinary science and management review and use for improving management in the CALFED area of concern
Journal publications	Peer-review	At least two articles in journals of international reputation

6. Data Handling and Storage

Data collected in the field or received from the laboratory will be entered into a database compatible with MS Access and stored in both paper form and electronically with appropriate disk drive backups on a weekly basis. Discharge and climatic data collected from the USGS and NOAA will also be stored along with water quality data. Sampling locations will be recorded on field maps and using a GPS in the field and then entered into a GIS stream coverage using arc-view for later digital transfer via CD Rom. Data analysis will be carried out using MS Excel, and an appropriate statistical package such as Delta graph, SAS or SPSS. Data will be submitted annually following the CALFED guidelines for paper, pdf and electronic transferal.

7. Expected Products/Outcomes

The most important outcomes from this work are associated with the transfer of the information into the community, local governments, and CALFED and the associated continued development and improvement of environmental management solutions that reduce the impacts of mercury on beneficial uses in the Napa River Watershed, San Pablo and Suisun Bays. There are two advances in technology expected from this work: 1. Improved recommendations for management of mercury in San Pablo and Suisun Bays through the refinement of the mercury budget and 2. Development of a reliable predictive numerical model to provide a unique new management tool for limiting bioaccumulation of meHg and for providing support for the reuse of wastewater in wetland areas as a solution for environmental remediation of mercury. In order to achieve the desired outcomes, there will be one final report submitted to CALFED and local partners, and at least two journal articles prepared for peer reviewed publication. The results, interpretations, conclusions and recommendations will be presented orally to our local partners during an evening or weekend workshop and to CALFED during a subsequent CALFED science conference.

8. Work Schedule

	2002				2003												2004												2005							
Task	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**
1a	■	■																																		
1b			■																																	
1c				■	■	■	■	■	■																											
1d										■	■	■	■																							
2a	■	■	■	■	■	■	■	■						■	■	■	■	■	■	■						■	■	■	■	■	■	■				
2b				■	■	■	■	■								■	■	■	■	■																
2c									■	■	■	■	■	■							■	■	■	■	■	■										
2d																											■	■								
2e																																	■			
3a	■	■	■	■	■																															
3b						■	■	■				■	■	■				■	■	■				■	■	■										
3c									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
3d															■	■					■	■					■	■				■	■			
4a										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5a																													■	■	■	■	■			
5b																																		■	■	
5c																																				■
6a																																				■
6b																																				■
7a		■			■			■			■			■			■			■			■			■			■			■			■	
7b					■												■												■							
7c	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
7d	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

B. Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP Science Program and CVPIA Priorities

On a multi-regional scale, this study provides information needed to ensure that restorations are not threatened by degraded water quality (MR-5). Mercury is directly addressed as a pollutant of concern, and linkages between dissolved oxygen and bioaccumulation will be investigated. Within the Bay Region, this study will supply management information essential to tidal, wetland and upland habitat restoration goals (BR-1, BR-2, BR-4, and BR-5). The load study will identify whether restorations are needed in the Napa River watershed to reduce mercury loads. The slough study will establish linkages between physical properties of sloughs and methylation efficiency. These linkages are essential to model methylmercury production rates before and after Baylands projects are completed. Progress towards these Bay Region goals will be advanced by a more quantitative model for methylmercury fluxes in the Bay. This affects higher order predators species, such as striped bass, California clapper rails, and California least terns.

2. Relationship to Other Ecosystem Restoration Projects

This study is complementary to the work undertaken by the CALFED ERP Mercury Project, as well as a wetland monitoring program in another proposal (Yee et al, 2001). The CALFED Mercury Project is accurately defining mercury loads from the Delta, whereas this study examines loads from a local watershed. The CALFED mercury project provided data on methylation rates in Bay sediments, while other proposal focus on wetlands. This study examines correlations betweem methylation efficiency and physical parameters in the interfacial regions between wetlands and sloughs, linking observations from the other two approaches in a cohesive model for mercury transport and methylation.

3. Requests for Next-Phase Funding

This section is not applicable to this proposal.

4. Previous Recipients of CALFED Program or CVPIA Funding

99-N07: Chronic toxicity of environmental contaminants in Sacramento splittail, CALFED Bay-Delta Program.
00-E04: Sonoma Creek Watershed, CALFED Watershed Program
99-B06: Association of ecology and human health impacts of mercury in the Bay-Delta Watershed, CALFED Bay-Delta Program
0145: Stewardship Support and Watershed Assessment in the Napa River Watershed: A Two-year Project, CALFED Bay-Delta Watershed Program 2001.
13320J032, NIS Guidebook- USFWS, - Bay-Delta Agreement Program
99-110, Spartina Control-Coastal Conservancy- Program-SF Bay Area conservancy, Introduced Spartina Eradication Project

5. System-Wide Ecosystem Benefits

One of the most important synergistic benefits is that we may find that restoration projects designed to improve dissolved oxygen can also reduce mercury methylation. Regulatory requirements to reduce mercury levels in fish could be attained by implemented watershed management strategies to reduce DO-depleting substances.

6. Additional Information for Proposals Containing Land Acquisition
This section is not applicable to this proposal

C. Qualifications

Lester McKee, Ph.D., Environmental Scientist II. Lester was born in Ashburton New Zealand (NZ), graduated in geology with honors from Canterbury University, NZ before transferring to Southern Cross University, Northern New South Wales Australia. He carried out his PhD research in the fields of hydrology and nutrient biogeochemistry in a sub-tropical agricultural watershed. In 1997, Dr. McKee began work as a consultant in the Center for Coastal Management where he carried out management related field, laboratory, and desktop research for clients including local councils, Environment Protection Authority, Department of Land and Water Conservation, and the Brisbane River Management Group. Dr. McKee joined the staff of SFEI as Director of the Watershed Program in 2000 where his research diversified to include trace pollutant water and sediment quality, and loads. His main interests center around the design and implementation of studies that describe the cause and magnitudes of spatial, and temporal variability of water and sediment quality, and loads of sediments, nutrients, and trace substances in watersheds of the Bay Area. Studies and products completed to date as part of the SFEI team include an analysis of existing data and loads of mercury and other pollutants entering the San Francisco Bay from local watersheds using the simple model, comparisons of loads variability between sub-tropical and Mediterranean watersheds, an analysis of existing environmental data for restoration purposes in the Sonoma Creek watershed, the analysis of sediment, mercury, and related pollutant loads entering San Francisco Bay from the Central Valley, and the conceptual design of a regional monitoring program for water quality and loads from local San Francisco Bay tributaries. Apart from many consulting reports, Dr. McKee has published a number of articles in international journals, several book chapters, and many workshop proceedings, conference proceedings and abstracts.

Khalil Abu-Saba. Ph.D., Senior Scientist. Dr. Abu-Saba served on the staff of the San Francisco Bay Regional Water Quality Control Board from 1998 to 2001, where he developed a Total Maximum Daily load for mercury in San Francisco Bay. He has studied trace metal geochemcial cycles of San Francisco Bay since 1990, conducting trace metal sampling and analysis on thirteen sampling cruises on San Francisco Bay. He received his M.S. in Marine Science and his Ph.D. in Chemistry from the University of California, Santa Cruz. Dr. Abu-Saba's research has been published in five peer-reviewed publications and presented in over forty national conferences.

Donald Yee, Ph.D., Environmental Scientist I. Dr. Yee received his B.S. in Chemical Engineering and his Ph.D. in Environmental Engineering from M.I.T. His dissertation research focused on competitive interactions of trace metals on phytoplankton. Prior to joining SFEI in 1999, he has had experience in post-doctoral research on carbon geochemistry and consulting in the private sector on environmental regulatory policy.

Jon Leatherbarrow, Environmental Analyst III. Mr. Leatherbarrow received his B.A. in Environmental Earth Sciences from The Johns Hopkins University in 1994 and his M.S. in Environmental Engineering from the University of California at Berkeley in 1998. He performed his Master's research on the speciation of trace metals in wastewater effluent. Mr. Leatherbarrow joined the staff of SFEI in 1998 and works primarily on the Regional Monitoring Program, Coastal Watershed Mass Emissions, and the Grasslands Bypass Project.

D. Cost

1. Budget

All the budget info has been uploaded onto the web

2. Cost-Sharing

There is no cost sharing associated with this project

E. Local Involvement

As outlined in the proposal solicitation package, field survey projects for which specific locations are not yet identified at the time of the proposal need not seek approval from private property owners prior to submitting the proposal.

In this proposal, phase one will involve sample site selection, meeting with local public agencies and members of the community to gain approval for access when and if it is required. We anticipate that the majority of the sample locations in the watershed can be chosen with minimal access problems. SFEI already has close working relationships with the Napa RCD, Napa Vintners and Growers, and Friends of the Napa River through other projects that will be ongoing through 2003 and beyond. We will offer the community the opportunity to get involved by volunteering to assist members of the SFEI field crew during the field data collection process. SFEI's past experience has shown the best way to communicate scientific method and information is through the "field classroom". We intend to continue to interact with the Napa community using this forum.

F. Compliance with Standard Terms and Conditions

We have read the terms and conditions outline in the Ecosystem Restoration Program 2002 proposal solicitation package. We can see no cases where we will not be in compliance.

G. Literature Cited

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