I-050

Lawrence Livermore National Laboratory

Isotope Sciences Division, MS L-231
Lawrence Livermore National Lab
P.O. Box 808
Livermore, CA 94550

Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

July 24, 1997

Dear Ms. Hansel:

Please find enclosed ten copies of the two page executive summary requested for pre-proposal inquiries in the 1997 Category III RFP. A perusal of the summary will reveal that the main focus of the proposed work is to delineate loadings and sources of trace metals to the delta from the two main rivers. We think we are imminently qualified to address that issue, which is of major importance in determining the ecosystem significance of the trace metals mentioned in the summary. We are also capable of measuring trace metals in fish tissue, sediments, benthic biota, and plants at very low levels. We are not, however, qualified to assess the biological effects of trace metals on chinook salmon or steelhead trout. If given a favorable reply to the enclosed summary, we would explore the option of subcontracting with a fisheries biologist, or collaborating with another researcher funded by Category III, who could determine the effects of the trace metal levels we determine on the priority species.

Thank you for consideration of our pre-proposal. We look forward to your reply.

Sincerely,

Jean E. Moran
(510)423-1478
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a. Project Title: Distinguishing Non-Point Trace Metal Sources for Analysis of Their Effect on Upper Trophic Level Organisms

Applicant Names: Jean E. Moran and Bradley K. Esser, Lawrence Livermore National Lab, L-231
P.O. Box 808, Livermore, CA 94550

b. Project Description:

Spatial and temporal variability in trace metal concentrations in water flowing into and circulating in the delta has a large effect on their bioavailability and toxicity to Chinook salmon and other high tropic level organisms. Except for wastewater discharges and industrial effluents, sources of and variability in trace metal inputs for the delta are very poorly known. In particular, metals loadings from urban runoff and their fate downstream are have not been studied. In keeping with the goals of CALFED Category III funding, we propose to map out spatial and temporal variability in trace metals of concern (including As, Cd, Cr, Hg, Ni, Zn, Se, Pb, Mo, Mn, and Al), to determine whether metal loads might have a detrimental effect on salmon populations (based on review of literature data) and to estimate the feasibility of temporarily retaining "first flush" stormwater runoff from the major urban areas in the watershed for treatment or gradual release. The major focus of our study will be to determine non-point source trace metal contributions to the Sacramento and San Joaquin Rivers. These would be distinguished from the natural erosional input, agricultural runoff, and mine drainage by studying spatial and temporal variability for characteristic elements or suites of elements. While the primary objective would be to determine trace metal loadings and fate in fresh water, our analytical capabilities would allow measurement of trace metals in brackish or sea water, fish tissue or bone, benthic organisms, and plant material, for comparison with levels in fresh water.

c. Approach/Tasks/Schedule:

Year 1: Collect weekly samples from stormwater drains from Sacramento and Stockton for the winter months, monthly samples for other months. Collect upstream samples on the Sacramento and San Joaquin Rivers monthly. Collect monthly samples from several locations in the delta proper, and determine mixing and fate of Sacramento and San Joaquin components. Analyze waters (dissolved and particulate) for As, Cd, Cr, Hg, Ni, Zn, Se, Pb, Al, Mo, Mn, and Fe by inductively coupled plasma mass spectrometry, using isotope dilution techniques for low levels when necessary. Also measure salinity (or TDS) and TOC to examine issues of transport and fate of metals in the delta.

Year 2: Determine possible locations for re-sampling based on year 1 data. Interpret data by examining ratios to Fe and Al (for natural erosional component), and comparing Hg, Cu, and Cd concentrations at various locations (for mine drainage component). Se and Mo levels may expose agricultural runoff. Pb and Zn may be diagnostic for urban runoff component. Compare acquired data to literature studies indicating levels of trace metals that adversely affect salmon and other fish. Compare levels found in freshwater inputs to reported levels in delta sediments, benthic fluxes, and lower trophic level biota. Estimate effectiveness and benefits of treatment of urban stormwater drainage, or other remediation.

d. Justification for Project and Funding by CALFED:

This project would address several of the areas identified by the CALFED Bay-Delta Program as lacking in scientific knowledge. The ecosystem significance of trace metals from urban runoff is largely unknown, due to a lack of knowledge of total loading and of spatial and temporal variability in inputs. Insufficient analytical capability has resulted in many studies reporting "below detection limit" for many elements, which prohibits any meaningful analysis of total loadings. Lack of adherence to state-of-the-art clean techniques for freshwater sampling makes most pre-1992 data unreliable. Unknowns in the proportions contributed by the various sources prevents analysis of possible remedies. Laboratory studies of effects on salmon and other fish are hindered by a lack of knowledge of when and at what levels the organisms are subjected to trace metals in the water, sediment, or food sources. This proposed study would potentially provide "fingerprints" for the various sources of trace metals to the delta, and would allow quantification of inputs from urban runoff, natural and agricultural erosion, and mine drainage. The analytical capability of the ID/ICP-MS method should result in no reports of "BDL".

e. Budget Costs - 2 yrs (includes overhead):
Sampling: $50K per 100 samples, total = $100K
Metals Analysis by ICP-MS: $30K per 100 samples, total = $60K
Labor (400 hours for Jean Moran · 400 hours for Brad Esser): $60K
Total $220K

f. Applicant Qualifications:

Jean E. Moran, Ph.D., is a new member of the isotope hydrology group in the Isotope Sciences Division of Lawrence Livermore National Laboratory. She will coordinate the project, analyze the trace metal data, and supervise and take part in sampling. She graduated with honors with a B.S. in Geology and a B.A. in Physics from the University of Rochester (1983). She received a M.S. in Geophysics from the University of Washington (1986), and after service as a teacher in the U.S. Peace Corps, pursued a Ph.D. in Geology from the University of Rochester (1994). Most recently, she held a Post Doctoral position at Texas A&M University. A major component of her research there was with a trace element research lab, which had major contracts with Status and Trends, and the Fish and Wildlife Service, studying trace metal levels in water, sediments, and biota of the Texas Gulf Coast, Galveston Bay, the Houston Ship Channel and San Jacinto River.

Bradley K. Esser, Ph.D., is a Staff Scientist with the Isotope Sciences Division of LLNL and will head up the ID/ICP-MS analysis, and take part in data interpretation. He received a B.S. (with highest distinction) in Ecology and Evolutionary Biology from the University of Arizona (1980), as well as a B.S. (with high distinction) in Geosciences from the same institution (1983). His graduate education included receipt of a M. Ph. (1985) followed by a Ph.D. (1991), both in Geology and Physics from Yale University. For his doctoral dissertation, Dr. Esser focused on osmium isotope geochemistry of terrigenous and marine sediments. Relevant recent research activities in which he has been involved include:

- Development of selenium chemistry and isotopic analysis to document how isotopic fractionation of Se can be used to understand Se cycling and remediation
- Development of an integrated tracer approach on submarine-collected seawater samples to constrain freshwater balances and trace-metal recycling in the Arctic Ocean
- Initiating a trace metal study with the Alameda County Water District to determine the fate of trace metals in recharge ponds, sediments and ground water.

g. Monitoring and Data Evaluation: Since our expertise is in analysis and interpretation of low level trace metals in water, this is the major focus of the proposed project. Monitoring will take place as described above, and could continue depending on the level of funding, and results from the two year study. High sampling frequency, use of ID/ICP-MS for analysis, and strict adherence to trace metal clean protocol are the aspects of the project that would set it apart from previous studies in freshwater. Evaluation of the ecosystem significance, if significant trace metals loadings are found, will be by comparison with previous and ongoing studies. Measurement of trace metal concentrations in fish tissue or bone, benthic organisms, or plant material could be included, to further delineate ecosystem significance. Data from biota would be interpreted by a subcontractor with experience in fish toxicology.

h. Local Support/Coordination with other Programs/Compatibility with CALFED objectives: The importance of accurate low-level trace element measurements in fresh water has only recently been recognized by the scientific and policy-making communities. While recent studies by the USGS, and by the Municipal Water Quality Investigations Program address this issue, there are large gaps in knowledge of spatial and temporal variability for the metals listed. Two recently funded projects being carried out by our group at LLNL also include a component of trace metal measurements in fresh water; the main focus being identification and tracking of non-point source pollutants using isotopes, in the delta tributaries.