Summary Information

US Geological Survey

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Amount sought: $996,307

Duration: 36 months

Lead investigator: Dr. Charles Alpers, U.S. Geological Survey

Short Description

This project will examine hyporheic water quality and the potential for methylmercury exposure in salmonid redds on the Lower American River. Three existing CVPIA gravel restoration sites will be evaluated for indicator conditions that could potentially lead to methylmercury production, and water samples will be collected and analyzed for a variety of compounds that are related to methylmercury production. These include redox, sulfate or iron, low dissolved oxygen conditions, reactive mercury, organic carbon, pH and temperature.

Executive Summary

This project examines hyporheic water quality and the potential for methylmercury exposure in salmonid redds on the Lower American River. Three existing CVPIA gravel restoration sites will be evaluated for indicator conditions that could potentially lead to methylmercury production, and water samples will be collected and analyzed for a variety of compounds that are related to methylmercury production. These include redox, sulfate or iron, low dissolved oxygen conditions, reactive mercury, organic carbon, pH and temperature. Hypothesis−driven study design will examine the potential for methylmercury production in restored and unrestored gravel sites, and indicators will be developed so that project results can be applied to other restoration sites.

Sampling will focus on 18 Fall−run Chinook salmon redds and five background sites. Geochemical sampling will be concentrated during the Fall Chinook run, and additional site characterization will be conducted during the following Spring and Summer seasons. Redds will be instrumented with longitudinal and lateral arrays of mini−piezometers. This will allow water quality sampling shortly after egg emplacement, during egg and alevin development, and during emergence of the fry. This project is designed for a two year duration to allow collection of a statistically significant data set, and a CSUS graduate student will conduct M.S. thesis research as part of the project. Sampling events in the second year of the project focus on areas where initial results identify the potential for methylmercury production. Macro−invertebrate and freeze−core sediment samples will also be collected to complete the water/sediment/macro−invertebrate food chain. Special attention will be devoted to microenvironments in and around the egg pocket of newly formed redds, where methylmercury production has the potential to alter developing salmonid eggs and alevine during a critical life phase.

Results are scalable to other watersheds and other restoration projects, and may have fundamental implications for future restoration strategy. If the methylmercury is detected in significant concentrations in redds, indicator conditions of low hyporheic dissolved oxygen content, high organic carbon content, and excess fine sediment may be sufficient to warrant background mercury studies before gravel is disturbed as part of ecosystem restoration projects.

Comparison of Hyporheic Water Quality and Methylmercury Exposure in Salmonid Redds within Restored and Unrestored Gravels in the Lower American River

A) Project Description: Project goals and scope of work

A. 1) Problems, goals and objectives:

Restoration of spawning habitat for anadromous, salmonid fish is a high priority effort in many of the tributary rivers to the Delta. The construction of large dams on nearly all major rivers draining the western slope of the Sierra Nevada has resulted in substantial loss of habitat for several species of salmonids, including the Central Valley steelhead Evolutionarily Significant Unit (ESU) (*Oncorhynchus mykiss)* and several runs of Chinook salmon (*Oncorhynchus tshawytsha*): the fall/late-fall run, the winter run, and the spring run (CALFED, 2000). Three of these species (e.g. Central Valley steelhead ESU, winter-run Chinook salmon, and spring-run Chinook salmon) are listed as either endangered or threatened by the federal and (or) state governments. All of these salmonids (including the fall/late-fall run Chinook salmon) have been designated by CALFED as “big R” species for which the goal is recovery of population and habitat (CALFED, 2000). The recovery of the fall/late-fall run Chinook salmon is important to the State’s economy, with regard to both recreational and commercial fishing.

Gravel augmentation and manipulation has been practiced in numerous rivers in the Bay-Delta drainage area (Kondolf, 2004). In some areas, gravel used for river augmentation consists of tailings from gold-dredging operations that were widespread from the 1890’s to the 1960’s throughout the Central Valley (e.g., Clear Creek, Shasta County, Ashley et al., 2002). It is well documented that mercury was used extensively during gold dredging to enhance the recovery of gold by amalgamation, and that a considerable quantity of mercury was lost to the environment during this activity (Alpers and Hunerlach, 2000; Churchill, 2000; Hunerlach et al., 2004). Recent studies in Clear Creek (Shasta County; Ashley et al., 2002) and the lower Yuba River (Yuba County; Hunerlach et al., 2004) indicate that dredge tailings are typically contaminated with mercury at several times background (pre-mining) levels, and that mercury concentrations are highest in the fine-grained sediment.(silt and clay fractions).

Concerns have been raised regarding possible harmful effects to anadromous fish from exposure of early life stages to methyl mercury (MeHg) in spawning redds within Sierra Nevada rivers affected by historical gold mining and associated mercury amalgamation practices (Wiener et al., 2003, 2004). Experimental studies on fathead minnows (Hammerschmidt et al., 2002) indicated that reproduction was affected by exposure of eggs and early life stages to concentrations of aqueous MeHg above 2.0 nanograms per liter (ng/L, or parts per trillion). Another concern regarding MeHg exposure to fish is the possible role of MeHg as an endocrine disruptor. Drevnick and Sandheinrich (2003) conducted experimental studies on fathead minnow, showing hormonal effects from MeHg exposure. Fynn-Aikins (undated) documented hormonal disruption in bass exposed to MeHg in the Florida Everglades. To date, no studies have addressed MeHg concentrations in hyporheic water associated with salmonid redds in California rivers affected by historical mining.

The American River is an important ecological and economic resource in northern California. In addition to being the largest urban river and receiving the heaviest recreational use in the state (Williams, 2001), the American River produces approximately one-third of the fall-run Chinook salmon in northern California (Chappell, 2004). Construction of Nimbus Dam in 1954 limited upstream migration of returning adult salmon, and suitable spawning habitat is reduced to the 8-mile reach below Nimbus Dam (Snider et al., 1992). The Nimbus Fish Hatchery was constructed to mitigate the loss of habitat, and currently releases about 4 million juveniles per year to the San Francisco Bay-Delta. Concerns about the biological implications of hatchery fish are placing increasing emphasis on the value of naturally spawned salmonids (Unwin, 1997), and these issues were addressed when the Central Valley Project Improvement Act (CVPIA) called for doubling the numbers of naturally produced anadromous fish in Central Valley Rivers.

In the mid-1990's the Bureau of Reclamation (using CVPIA-related funding) and the California Department of Fish and Game (DFG) began an evaluation program that ultimately resulted in gravel augmentation and manipulation experiments at three sites on the Lower American River (fig. 1). Initial evaluation of sites (Vyverberg et al., 1997) was followed by construction in 1999, and continued fish monitoring from 2000 to the present. Post-project spawning gravel conditions have been evaluated by Horner et al. (2003), a project that will continue through August, 2005. Two of the three restoration sites have retained their gravel since 1999, and thus are good candidates for a comparative study of hyporheic water quality between restored and unrestored spawning areas. At the Sacramento Bar site (fig. 2) the gravels were added to a riffle zone, which is a densely spawned area. At the Lower Sunrise Access site (fig. 3) some of the gravel was added on the edge of a pool environment, which is less well suited for spawning habitat. Nevertheless, some of the added gravel is being used by returning fall-run salmon.

In spite of this intensive pre- and post- project assessment, there are still significant gaps in the monitoring and understanding of Lower American River spawning gravel augmentation sites. This proposal addresses a significant water-quality and habitat issue, through intensive monitoring of geochemical conditions and water-quality parameters in Fall-run Chinook salmon redds.

2. Justification (including conceptual model and hypotheses)

Hypothesis 1: *In areas with sediment contaminated with mercury from historical mining, salmonid redds with low dissolved oxygen in hyporheic water provide an environment favorable to development of methylmercury concentrations*

Hypothesis 2. *Methylmercury exposure has harmful effects on early life stages of anadromous fish.*

Hypothesis 3: *The severity of methylmercury contamination and bioaccumulation in a river system can be assessed effectively by analyzing mercury and methylmercury concentrations in river water and biosentinel macroinvertebrates.*

The combination of several conceptual models are needed to put the problem of methylmercury exposure in salmonid redds in proper perspective. First, the anadromous fish cycle must be considered in the context of river geomorphology. Salmonids such as the fall-/late-fall-run Chinook salmon spend most of their adult life (typically 2-4 years) in the ocean, and then generally return to the river where they were hatched and reared, where they spawn and die. Riffle zones are the most favorable habitat for redds (fig.4).

Groundwater / surface-water interactions in the hyporheic zone are important processes in the riffle and redd environment. Several studies (e.g. Soulsby et al., 2001; Malcolm et al, 2003; Horner, 2003) have shown that rivers tend to recharge shallow groundwater at the upstream end of riffle zones, and that groundwater discharges back to the river within the riffle zone and at its downstream end. The quality of water in the hyporheic zone will depend on physical mixing of surface water and ground water as well as biogeochemical processes involving water-sediment-organic interactions (fig. 6). In the presence of sufficient decaying organic matter, dissolved oxygen levels can become depleted in the hyporheic zone (Soulsby et al., 2001; Horner et al., 2003).

Mercury distribution in Sierra Nevada watersheds is dominated by anthropogenic mercury that was lost to the environment during historical gold mining, beginning with the California Gold Rush in 1848 (Alpers and Hunerlach, 2000). The discovery site at Sutter's Mill near Coloma is in the South Fork American River watershed. Abundant visible mercury is present on the river bed at Lotus, a few miles downstream of Coloma (R. Humphreys, State Water Resources Control Board, written communication, 2004). Hydraulic gold mines, active primarily from the 1850s until the mid-1880s, are thought to be the main source of mercury contamination in Sierra Nevada watersheds, however mercury was also used extensively in gold dredging and hardrock mining operations. Churchill (2000) estimated that about 10,000,000 pounds of mercury were lost to the environment from mining and processing of placer gold deposits (including hydraulic and dredging), and that another 3,000,000 pounds were lost from stamp mills at hardrock gold mines.

Methylmercury is a potent neurotoxin, and causes health effects in humans; fetuses and young children are especially vulnerable. The state of California's Office of Environmental Health Hazard Assessment has issued fish consumption advisories in two parts of the Sierra Nevada: the Bear-Yuba watersheds (Klasing and Brodberg, 2003) based on data of May et al. (2000) and the Lower American River watershed (Klasing and Brodberg, 2004) based on data of Saiki et al. (2004) and available TSM data.

Numerous factors influence the methylation of mercury, which is the key step toward mercury bioaccumulation. The process of mercury methylation is thought to be primarily microbial, driven by anaerobic bacteria such as sulfate-reducers (Gilmour et al., 2002) and perhaps also iron-reducers (Warner et al., 2003). Some of the key environmental variables that influence mercury methylation and demethylation processes are: temperature, oxidation-reduction (redox) potential, dissolved oxygen, pH, organic carbon, and various chemical forms of iron and sulfur.

Recent studies have shown that methylmercury can have toxic and sublethal effects on developing fish. (Hammerschmidt et al., 2002; Wiener et al., 2003 and references therein). Also, methylmercury can act as an endocrine disruptor (Drevnick and Sandheinrich, 2003), affecting hormone levels which can affect reproduction.

To date there have been no studies of methylmercury exposure in salmonid redds. Given the extensive mercury contamination in Sierra Nevada rivers and the importance of the anadromous fish restoration efforts, it is important to evaluate this.

There are several ways to assess MeHg exposure in redds. The most direct way is to sample the pore water in the hyporhreic zone (to evaluate Hypothesis 1). Our proposed sampling strategy is shown in Figure 6. The gravel restoration sites on the American River provide the opportunity to compare restored with unrestored gravels in areas used by fall-run Chinook salmon for their redds. The Sacramento Bar site has both restored and unrestored gravels in riffle zones, and unrestored gravels in a glide/run zone. The Lower Sunrise Access site has both restored and unrestored gravels in a glide/run zone and unrestored gravels in a riffle zone. These six environments will be sampled to compare the effects of restoration by gravel that is not contaminated with mercury (an off-stream, “virgin” gravel deposit was used for the 1999 restoration work).

To put the results in the context of overall contamination in river reach, it is important to analyze methymercury in invertebrates and the water column (Hypothesis 3). By sampling invertebrates and the water column both upstream and downstream of the study reaches, this will provide transfer value by giving context for comparison with other rivers

A. 3) Previously funded monitoring:

Previous work at the Lower American River gravel restoration sites began in the mid-1990’s, with background monitoring and assessment by DFG (Vyverberg et al., 1997). This work identified several spawning habitat limitations on the Lower American River, including armoring of the surface layer (all sites discussed in this proposal), presence of excess fine material (Lower Sunrise site) and presence of excess coarse material (Sailor Bar site). Individualized treatments were designed for each site, and in 1998 and 1999 three gravel manipulation experiments were performed as a test of different treatment techniques. Techniques included gravel ripping to disrupt the armored surface layer, mixing of surface and subsurface gravels, and addition of appropriate-sized gravel in cases where existing sediment was too fine or too coarse.

A summary of gravel added at each site is given below (Kris Vyverberg, personal communication):

Habitat Site	Project area dimensions	Amount of Gravel to be Added to the River at Each Project Site
Sailor Bar (a)	200' x 50' = 10,000 ft^2	gravel to a depth of 2' [200'x50'x2' of gravel = 20,000 ft^3 = 1,000 tons of gravel]
Sailor Bar (b)	200' x 50' = 10,000 ft^2	gravel to a depth of 2' [200'x50'x2' of gravel = 20,000 ft^3 = 1,000 tons of gravel]
Sailor Bar (c)	200' x 50' = 10,000 ft^2	gravel to a depth of 1' [200'x50'x1' of gravel = 10,000 ft^3 = 500 tons of gravel]
Lower Sunrise	450' x 50' = 22,500 ft^2	gravel to a depth of 1' [450'x50'x1' of gravel = 22,500 ft^3 = 1,125 tons of gravel]
Sacramento Bar	450' x 50 = 22,500 ft^2	gravel to a depth of 2' [450'x50'x2' of gravel = 45,000 ft^3 = 2,250 tons of gravel]

Table 1: Habitat sites, project dimensions and volume of gravel added to each site during Phase 2 gravel manipulation experiment.

Costs for 1998 included $62,612 from DFG for assessment and oversight, and $272,260 from CVPIA/USFWS for project permitting, project supervision, and construction. Costs for 1999 included $62,612 from DFG for project oversight and assessment, and $230,000 from CVPIA/USFWS for design and construction. The intended result from these actions was to improve spawning habitat, and to allow later comparison of the effectiveness of different treatment methods on spawning gravels that had a range of pre-project physical limitations. Since that time US BOR/CVPIA has provided approximately $10,000 per year for low level air photos that document spawning use during the Fall salmon run.

Post-project assessment was initially limited to a relatively brief internal document that summarized spawning use of the manipulated gravels after the project was completed. This was rectified in 2002, when CVPIA funds were provided for comprehensive monitoring and assessment of the gravel restoration sites (Horner et al., 2003). These funds have been made available for three consecutive years, and have resulted in a sound understanding of sediment grain size, hyporheic conditions, major element water chemistry, upwelling and downwelling conditions, and spawning density (Horner et al., 2003). Total monitoring project cost for 2002 and 2003 was $201,000, and the 2004 project is funded for an additional $97,390.

Post-project monitoring (Horner et al., 2003) reveals several changes when viewed at a macroscopic scale. Edges of the project areas are no longer distinct, and blade or tread marks from the heavy equipment have faded. These changes are partially due to human influence (hikers, dog walkers and fishers), but river processes have also modified the sites. Small changes in shoreline configuration are seen in recent air photos. There is a slight tail of material on the downstream (left) side of each study site, and this is probably caused by coarse sediment mobility during high flow events. Colonization by pioneer species and soil development is significant processes at some sites, and fine sediment has infiltrated a quiet, backwater area at

Lower Sunrise Access. The result is a "seasoning" of the newly added gravel that alters the original appearance. Macroscopic changes at each site are summarized below:

Gravel manipulation site	Downstream coarse sediment tail	New vegetation	Soil development	Accumulation of fine sediment
Sacramento Bar	X	minor	minor	
Lower Sunrise Access	X	X	X	X
Sailor Bar	X	minor		

Table 2: Macroscopic changes at study sites.

Lower Sunrise Access has experienced the most changes, with accumulation of fine sediment, colonization by willows and grasses, and soil development on the surface of new gravel. This gravel bar has the lowest gradient and lowest associated flow velocities of the three study areas, and under some flow conditions is serving as a site for accumulation for fine, organic-rich sediment. Low dissolved oxygen content is also observed in hyporheic pore water at this site. The combination of low dissolved oxygen, excess fine material and excess organic material creates a potential site for the production of methylmercury, *IF* there is also a source for elemental mercury. This potential for methylmercury production will be examined during the monitoring and evaluation work described in this proposal.

A. 4) Approach and Scope of Work

The proposed work is divided into eight major tasks, as described below. Each task is an integrated approach to meeting the goals and objectives of the study, with participation from both principal investigators and staff or students from USGS and CSUS.

Task 1. Project Management

This task includes supervision of USGS staff (by Alpers) and CSUS students (by Horner). Semi-annual reports will be prepared for CALFED, summarizing programmatic and budgetary progress. A Quality Assurance Project Plan will be developed, documenting quality assurance and quality control procedures for chemical and physical measurements that will be made during the project. A site-specific safety plan will be written prior to beginning field work.

Task 2. Physical Characterization of Redds

The local hydrologic conditions and the hydraulic properties of the stream bed in the vicinity of the redds will be characterized by the CSUS team. This effort will be the major focus for the M.S. thesis of a CSUS graduate student in the Geology Department. Hydrologic characterization methods were described by Horner et al. (2003).

Redds will be instrumented with mini-piezometer arrays that allow measurement of physical and geochemical conditions in and around redd locations. Longitudinal piezometer arrays will consist of upstream, egg pocket, tailspill and downstream monitoring locations, and will include depths of 30 cm and 60 cm in the gravel. A subset of the redds will also be instrumented with lateral transects of piezometers to examine the effects of lateral flow through the gravel. Sites will be sampled four times during the spawning and incubation period, and dissolved oxygen content will be used as a performance measure for the project, since areas with low dissolved oxygen content are potential sites for methylmercury production.

Measurements will include surface water depth and velocity, dissolved oxygen (DO) content of surface water and hyporheic water, pH, electrical conductivity (EC), and intergravel temperature. Surface water DO values will be recorded, and compared to subsurface (pore water) DO levels using a YSI field meter, peristaltic pump and flow-through chamber. This technique minimizes contamination from atmospheric oxygen, and maintains appropriate flow velocity past the DO probe tip. Temperature will be measured with a Fluke thermocouple meter and type “K” thermocouple wire, inserted into the mini-piezometers. This gives accurate inter-gravel temperature during field sampling events. Upwelling and downwelling conditions and vertical head gradients will be measured using a bubble manometer board (Horner and Bush, 2000). This compares hydraulic head between the river and shallow depths in the gravel bar, and has been identified as a key factor in spawning site selection (Barnard and McBain, 1998; Geist and Dauble, 1998). Surface water depth and velocity will be measured during the spawning season using a Price AA or Pygmy current meters mounted on a topset wading rod (Wilde and Radtke, 1999). Pore water will be collected for immediate analysis of nitrogen species, and a student technician will conduct the analyses with a Hach test kit and portable spectrophotometer.

Task 3. Water Sampling and Analysis
Subtask 3A. Sampling porewater from redds.

Eighteen redds will be instrumented, three each in six different categories (see section A.2). Each redd will be instrumented with six collection ports (see fig. 6). Each port will be sampled three times during the egg incubation period, at approximately 20-day intervals beginning in early October.

Subtask 3B. Sampling river water

Five sites, above, withing and downstream of the study reach, will be sampled with integrated methods, on the same three occasions that the pore waters are sampled in task 3A.

Subtask 3C. Sample preservation and analysis

See Alpers et al. (2000a).

Task 4. Biological Sampling and Analysis
Task 4A. Macroinvertebrates
(See Slotton reports.)

<u>Task 4B. Early life stages of anadromous fish.</u>

Task 5. Sediment Sampling and Analysis

Sediment will be sampled at the redd sites using freeze coring methods (after Evenson, 2001).

Task 6. Data Management and Statistical Analysis

Task 7. Integration and Reporting

Task 8. Outreach and Public Involvement

A. 5) Feasibility:

The proposed work is both feasible and appropriate given the expertise of the principal investigators and the three-year timeline outlined in this proposal. Field studies will be conducted on public land belonging to the American River Parkway, and fisheries biologists from the U.S. Bureau of Reclamation and DFG will be involved with redd sampling and permitting. Sampling or "take" of biological specimens will be limited to Fall-run Chinook salmon, so that species listed as endangered or threatened by state and federal agencies are not impacted. Collection permits for water samples and biological specimens will be obtained from DFG. Land and river access permits are available through Sacramento County Parks using relationships established during existing monitoring programs. There are no additional landowners or affected third parties.

A. 6) Expected outcomes and products:

Expected outcomes from this project include two peer-reviewed journal articles, a master's thesis, a USGS data-series report, a USGS fact sheet, talks at professional meetings, and outreach presentations by both principal investigators in appropriated venues. In addition, semi-annual reports to CALFED will be prepared throughout the project, documenting programmatic and budgetary progress.

Peer-reviewed manuscripts will be split between the principal investigators based on their expertise. Findings on geochemical relationships, mercury and methylmercury, trace-metal, and toxicity will be addressed by Dr. Alpers, with contributions from experienced USGS collaborators. Physical characterization of redds, inter-gravel flow and analysis of the substrate will be submitted by Dr. Horner, with assistance from the CSUS graduate student. The USGS fact sheet will allow quick presentation of results in a format that is accessible to the general public.

Technical presentations will be given at annual meetings of the American Geophysical Union and the Geological Society of America. Appropriate peer-reviewed journals would be, but are not limited to: Environmental Science and Technology, Water Resources Research, Canadian Journal of Fisheries and Aquatic Sciences, North American Journal of Fisheries Management, and Regulated Rivers.

The graduate student selected for this project will complete an M.S. thesis prior to graduation from CSU Sacramento. This student will work with his/her advisor to publish aspects of the completed thesis in an accredited journal, and the thesis will be archived in the CSUS library.

A. 7) Data Handling, Storage, and Dissemination

Chemical data on water-quality, sediment, and biological samples will be stored initially in spreadsheets, and then loaded into two databases: 1) a local Access database and 2) the USGS National Water Information System (NWIS). The local Access database is compatible with the CALFED-sponsored Bay Delta and Tributaries (BDAT) project. Once the data are approved for publication, the data will be uploaded to publicly accessible versions of BDAT and NWIS.

A. 8) Public involvement and outreach:

Communication of study design and results to stakeholders and the general public is an important aspect of this research project. This will be accomplished through a series of non-technical talks in community forums, public presentations and other outreach efforts. Potential venues include, but are not limited to: the American River Task Force (and its Fish Working Group), the Sacramento Water Forum, and Granite Bay Flyfishers. Dr. Horner has been the lead organizer of the Lower American River Science Conference (June 2003) and the upcoming American River Watershed Conference (April 2005).. Both principal investigators are also willing contributors to public forums and workshops that deal with water-quality and habitat issues in northern California rivers, such as regular meetings and special events sponsored by the Sacramento River Watershed Program, the Delta Tributaries Mercury Council, the California Abandoned Mine Lands Forum, and the CALFED Dredge Tailings Workgroup. Outreach with these groups will continue, and results will be presented in formats that are accessible to the general public, including a USGS fact sheet that will be published on the web. The scientific community will be involved with the project through data dissemination and peer review methods outlined in part A. 6 (above).

A. 9) Work Schedule

	Year 1	Year 2	Year 3
Task 1	X	X	X
Task 2	X	X	

Task 3	X	X	
Task 4	X	X	
Task 5	X	X	
Task 6	X	X	X
Task 7	X	X	X
Task 8	X	X	X

B. Applicability to CALFED Bay-Delta program ERP goals, ERP Draft Stage 1 implementation plan, and CVPIA priorities:

B. 1) Applicability to ERP and CVPIA priorities:

The proposed project is directly relevant to the following specific goals of CALFED's Ecosystem Restoration Program:

- *Recover 19 at-risk native species and contribute to the recovery of 25 additional species.*

Information gained during study of mercury, heavy metal and nutrient concentrations in Fall-run Chinook salmon redds will transfer directly to Winter and Spring Chinook runs and Winter Steelhead runs. These at-risk species have almost identical spawning habits, and the pathway for contaminant transfer by pore waters is the same. If significant concentrations of methylmercury or other detrimental compounds are identified in this study, future projects can be designed to minimize disturbance of areas with low dissolved oxygen content, high percentage of fine sediment, and resulting methylmercury production.

- *Rehabilitate natural processes related to hydrology, stream channels, sediment, floodplains and ecosystem water quality.*

This ERP goal will be addressed by minimizing impacts to water quality during restoration projects. Performance indicators will be identified, and will be transferable to other projects. Low dissolved oxygen content (in hyporheic water), high organic carbon content in sediment and high proportion of fine sediment are hypothesized to exacerbate the water quality problem. Areas with these indicators can be avoided during the design phase of restoration projects if methyl mercury or other contaminants are identified as water quality problems.

- *Maintain and enhance fish populations critical to commercial, sport and recreational fisheries*

This study will not take the next step and examine the effects of methylmercury or other pollutants on fish populations, but it may provide baseline data for future studies of this type. The underlying assumption of our proposal is that water quality pollutants in salmonid redds have a detrimental effect on eggs, juveniles, and adult populations. These effects may include lower survival to emergence, production of juveniles that are less fit, and reduction in adult populations.

- *Protect and restore functional habitats, including aquatic, upland and riparian, to allow species to thrive.*

The improved understanding of mercury, methylmercury, and other pollutants will provide important information to those responsible for protecting and restoring functional habitats, especially in aquatic environments and upland reaches. Publication of the comprehensive interpretive reports planned as part of the proposed work will allow this understanding to be transferred to other Central Valley watersheds.

- *Improve and maintain water and sediment quality to better support ecosystem health and allow species to flourish*

The additional data and data interpretation of water quality indicators that will result from this project will provide useful information to scientists responsible for improving and maintaining water and sediment quality in the ecosystem. Again, this has great transfer value to other watersheds of concern.

The proposed project also addresses several key issues with regard to the CALFED mercury strategy. In the section of the mercury strategy on "Asssessment of Mercury Sources," the quantification of sources of mercury and methylmercury loads is stressed, which is one of the main goals of the proposed work. In particular, the lower American River is the site of the most intense historical gold-dredging activity in the Sacramento River system. A recent study by USGS and UC Davis (Saiki et al., 2004) documented elevated mercury concentrations in sport fish from Lake Natoma, a reservoir on the American River just upstream of the study reach. In fact, Lake Natoma is one of only two water bodies in the Sierra Nevada for which a risk assessment has resulted in public health advice to avoid consumption of fish (in this case, channel catfish) for women and children under 17 (Klasing and Brodberg, 2004). This, combined with the high salmonid production on the lower American River, should make the American River one of the highest priority areas for improving understanding of mercury and methylmercury sources.

Another component of the CALFED mercury study is the "Quantification of effects of ecosystem restoration on methylmercury exposure." The proposed project will gather high-quality baseline data on mercury and methylmercury concentrations in restored gravels, which determine the exposure of aquatic species. Monitoring of other water-quality constituents that are important to mercury cycling, such as organic carbon, sulfate, and nutrients, will be included in this analysis.

B. 2) Relationship to other ecosystem restoration actions, monitoring programs, or system-wide ecosystem benefits:

Gravel restoration and gravel augmentation projects are common in northern California, with at least 139 projects conducted between 1968 and 2004. This has resulted in 400,000 yd^3 of gravel addition for spawning habitat improvements (Bruce Orr, Stillwater Sciences, written communication, Nov. 18, 2004). Many of these projects are in areas affected by historic gold mining, and modern stream gravels are often a combination of naturally occurring sediment and hydraulic mining waste or dredge tailings. Mercury is a common component of these sediments

(Alpers and Hunerlach, 2000), but the extent of mercury contamination and occurrence of mercury species is largely undocumented. This study will provide baseline data about potential biological effects on spawning salmonids. Geochemical information will be supplemented with sediment and biological indicators, allowing transfer to other projects. This study will also serve as a starting point for future mercury studies that deal with the biological effects of mercury on “Big R” species for which recovery is CALFED’s stated long-term goal.

On a local scale, proposed restoration projects on the American River will benefit from the new information. There are currently at least two proposals to increase function of the side channel at the Lower Sunrise site by lowering the bed surface. Work proposed in this project would provide a monitoring component for these projects.

Results from this study will have broader transfer value to new restoration projects in other areas, and will help identify situations where gravel manipulation is likely to disturb an existing mercury problem. Gravel manipulation projects may involve ripping, sieving, addition of stockpiled material and channel alteration. All of these activities have the potential to release sequestered mercury, and the effects of this release could be more serious than incremental gains in spawning habitat. Relationships between liquid, elemental mercury and the more toxic methyl mercury form, sediment grain size, organic carbon, and dissolved oxygen content will be used to develop simple indicators and identify geologically sensitive areas. This will allow inexpensive site assessment, and may prevent future problems with mercury release.

The principal investigators of this proposal intend to apply to the CALFED Science Program PSP for a project complementary to that described herein. The complementary project would address MeHg exposure in redds within the lower Stanislaus River and the upper Yuba River. In the Stanislaus River, there are ongoing studies in which low dissolved oxygen levels have been documented in artificial redds (Carl Mesick, oral communication, Nov. 17, 2004). In the upper Yuba River, extensive mercury contamination has been documented, which is spatially associated with MeHg bioaccumulation in invertebrates and small fish (Slotton et al., 2004b). The Technical Review Panel for the Upper Yuba River Studies Program has recommended that MeHg exposure be evaluated in the context of possible future introduction of steelhead and spring-run Chinook salmon to the mining-impacted areas (Wiener et al., 2004). The generation of comparable water-quality data for two or three river systems with varying degrees of mercury contamination and bioaccumulation would be very helpful in evaluating whether MeHg exposure in redds and its potential effects on anadromous fish should be of real concern to ecosystem managers.

C. Qualifications.

Dr. Alpers (USGS Water Resources Division) and Dr. Horner (CSUS Geology Department) are the principal investigators of the proposed project. They each will supervise members of the field sampling crew, and will co-advise the graduate student funded by this project. Both principal investigators will be involved with field work. Geochemical studies, sampling handling, and geochemical data management and interpretation will be coordinated by Dr. Alpers; hyporheic flow studies and sediment analysis will be supervised by Dr. Horner. Both principal investigators are experienced project managers. Administrative support will be provided by USGS staff and the CSUS Foundation.

Charles N. Alpers, Ph.D.

Since 1991, Dr. Alpers has been a Research Chemist with the U.S. Geological Survey, Water Resources Discipline, in Sacramento. He is the project chief for several USGS investigations related to mining and the environment. He has a bachelor's degree (magna cum laude) in Geological Sciences from Harvard University (1980), and a Ph.D. in Geology from UC Berkeley (1986). He has researched the world's most acidic mine drainage and associated sulfate minerals at Iron Mountain, California (Nordstrom and Alpers, 1999; Alpers et al., 2003 and references therein), traced mine drainage in surface waters and ground waters using stable and unstable isotopes (Hamlin and Alpers, 1996; Alpers et al., 1999; Church et al., 1999), and assessed colloidal transport and bioaccumulation of trace metals, including mercury, in the Sacramento River (Alpers et al., 2000a,b; Cain et al., 2000; Roth et al., 2001). He has organized two international conferences and a short course on the geochemistry metals in the environment has co-edited two books (Alpers and Blowes, 1994; Alpers et al., 2000c) and a special issue of a peer-reviewed journal (Seal et al., in press) based on these meetings.

Dr. Alpers participated as a task co-leader in a CALFED-funded project assessing mercury and methylmercury loads from the Cache Creek watershed (Domgalski et al., 2003, 2004). Since 1999 he has led a multi-agency, multi-disciplinary team that is investigating mercury contamination, methylation, and bioaccumulation associated with historical gold mining in the northern Sierra Nevada and Trinity Mountains of California (http://ca.water.usgs.gov/mercury/). He is USGS project chief of water-quality and sediment studies for the Upper Yuba River Studies Program, a CALFED-funded effort that is determining whether the introduction of wild salmon and steelhead above Englebright Dam is biologically, environmentally, and socio-economically feasible in the long-term. (Alpers et al., 2004; Christophel et al., 2004; Curtis et al, 2004; Flint et al., 2004; Slotton et al., 2004; Snyder et al., 2004a,b,c). Dr. Alpers is a member of several technical advisory committees related to mine remediation and mercury geochemistry, and he is frequently requested as a colleague reviewer by peer-reviewed journals.

Timothy Horner, Ph.D.

Dr. Horner is an Associate Professor in the Geology Department at CSU Sacramento, and has been a member of the department since 1993. He graduated from The Ohio State University in 1992 with a Ph.D. in Geology, and specializes in ground water/surface water interaction, physical and geochemical conditions in salmonid spawning habitat, field instrumentation, and near-surface water geochemistry. He teaches undergraduate and graduate hydrogeology classes at CSUS, and has advised 34 senior thesis projects that deal with local hydrogeology and sedimentology. Dr. Horner currently has six M.S. students working on thesis projects that deal with ground water/ surface water interaction. He has taught portions of groundwater short courses for the US Army Corps of Engineers and US Forest Service, and has co-led field trips for the Association of Engineering Geologists, Lower American River Task Force, and National Research Council River Science Review Panel. His work for the past three years has focused on gravel restoration sites on the American River, with emphasis on physical and geochemical conditions that relate to salmon spawning habitat. These projects have been funded by the US Bureau of Reclamation and CVPIA. A draft report of the first year spawning gravel study is available at: http://www.csus.edu/indiv/h/hornert/, and is *in review* for the California Department of Fish and Game Stream Evaluation Program Technical Publication Series (Horner et al, in review). Relevant presentations on local ground water issues include Horner (2004), Head and Horner (2004), Morita and Horner (2004), Horner and Bush (2000), Bush and Horner (2000) and Horner and Fahning (1997). Dr. Horner has extensive project management experience, and he has conducted several relevant hydrogeology projects:

2004/2005: Research grant from US Bureau of Reclamation and CVPIA for $97,390 for *Habitat suitability of Spawning Gravels on the Lower American River*.

2003/2004: Research grant from US Bureau of Reclamation and CVPIA for $103,000 for *Evaluation of American River Spawning Gravels.*

2002/2003: Research grant from US Bureau of Reclamation and CVPIA, for $98,000 to evaluate *Gravel quality in recently restored salmon spawning gravels on the lower American River.*

2001/2003: Key participant and contributing author for $400,000 grant from W.M. Keck Foundation for *Proposal to establish the W.M. Keck Foundation Facilities for applied hydrogeology at California State University, Sacramento.*

1999/2001: Lead author on NSF CCLI A&I grant for $105,152 titled *Water quality and stream flow as teaching tools in geology.*

1996/97: Co-author on $221,000 grant from W.M. Keck Foundation to *Establish Laboratories for hydrogeologic studies.*

Dr. Darell G. Slotton, University of California Davis

Dr. Slotton has directed applied research projects addressing heavy metal contamination and bioaccumulation issues in California aquatic ecosystems for over 15 years. He has led investigations of copper, zinc, and cadmium contamination at Iron Mountain Mine, Keswick Reservoir, and Camanche Reservoir, where sediment resuspension and metals transport, solubility, and bioavailability were studied. Since 1985, he has run a mercury monitoring and research program at Davis Creek Reservoir and a mercury analytical laboratory at UC Davis. Dr. Slotton led a research program throughout the gold mining region of the Sierra Nevada, focusing on benthic invertebrates and fish as sentinels of relative bioavailable mercury exposure. He conducted a multi-year study of mercury mass loading, bioaccumulation, and remedial options at the Mt. Diablo Mercury Mine and Marsh Creek watershed. Slotton has led numerous mercury investigations throughout the Cache and Putah Creek watersheds and has been a long-time participant in the Clear Lake Superfund Mercury Study. Other projects include ongoing investigations of mercury issues in the Truckee River and Pyramid Lake, Nevada, the Lake Titicaca watershed of Peru, and the Ayeyarwady River system of Myanmar. Since 1998, Dr. Slotton's primary focus has been directing several regional projects funded by the CBDA. One was a Delta study of mercury bioaccumulation, methylation, and the implications for wetlands restoration projects. Another focused on the Cache Creek watershed, determining the trophic relationships in localized mercury bioaccumulation, and the relationship to aqueous mercury chemistry. The Slotton lab was recently contracted by CBDA to help develop a fish mercury monitoring program throughout the Bay-Delta watershed. Recent collaborative efforts with the USGS include a mercury bioaccumulation study in relation to a potential large dam removal project on the Yuba River and a watershed study in the Lake Natomas mine tailings region.

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Obstacles to timely completion

There are no obstacles foreseen that would prevent the principal investigators from successfully completing the proposed work in the expected time frame.

Integration and collaboration

The project is planned as an integrated, collaborative approach involving experienced scientists a federal science agency (USGS), researchers at two local universities (CSUS and UCD) with considerable experience in the field area and similar settings, and local ecosystem managers (BOR, CDFG, and USFWS) who have conducted monitoring of the system for several years and who plan to continue those activities.

D. Cost.

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D. 1. Budget

The detailed budget is included on the web form. The possibility of funding certain tasks separately warrants some discussion. The core of the proposal, with direct relevance to the evaluation of Hypothesis #1 (methylmercury exposure to salmonids associated with hyporheic water in redds), involves Tasks 1, 2, 3, 6, and 7.

Task 4 (biological sampling and analysis) is important with regard to providing two additional measures of MeHg exposure: (1) direct measurement of early life stages of the salmonids (fall-run Chinook salmon) and (2) indirect measurement of mercury bioavailability using macroinvertebrates as biosentinels. The latter indicator is important with regard to putting the data from the American River in context, providing important information for those who would want to make comparisons with other river systems for which macroinvertebrate data are available or could be gathered at relatively low cost.

Task 5 (sediment sampling and analysis) is another indirect measure of MeHg exposure. If a correlation is observed between MeHg in sediment associated with redds and MeHg in other media to be sampled in Tasks 3 and 4, it would provide important information for improving the conceptual model of mercury cycling in rivers.

D2. Cost sharing

No other funding sources for the proposal have been requested. Ongoing CVPIA monitoring on the Lower American River (a project under the direction of Dr. Horner, funded by the Bureau of Reclamation, BOR) is scheduled through April 2005. Additional funding from that program is possible, but is not assured. If additional funding to Dr. Horner's group were granted by the BOR, in combination with the present proposal, a synergy would develop in terms of developing a sufficiently large data set on hydrologic properties and water quality in American River redds such that statistical significance of trends and apparently relations could be evaluated.

3. **Long-term funding strategy –**Long-term monitoring after the term of the ERP grant for which we are applying is not being considered as essential at this time.

E. Compliance with Standard Terms and Conditions.

The principal investigators on this proposal are willing to comply with the terms of standard ERP grant agreements, as described in the PSP's attachments. The standard grant agreement terms were reviewed and were found to be acceptable to the principal investigators. However, it has not yet been determined whether or not the terms and conditions are acceptable to USGS management.

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H. Nonprofit Verification.

(not applicable)

FIGURES

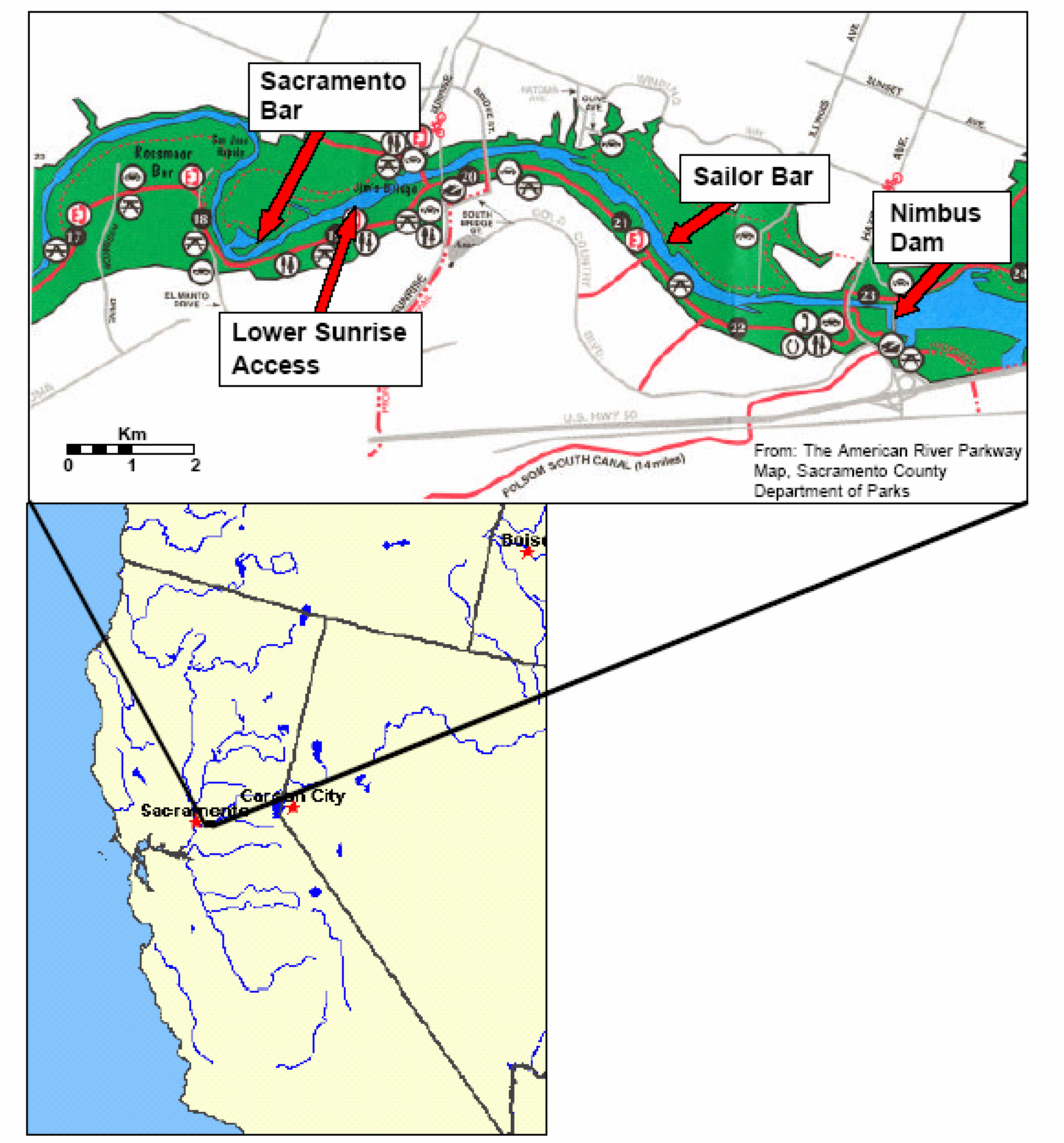

Figure 1. Location map of Lower American River showing areas of 1999 gravel augmentation. (from Horner et al., 2003)

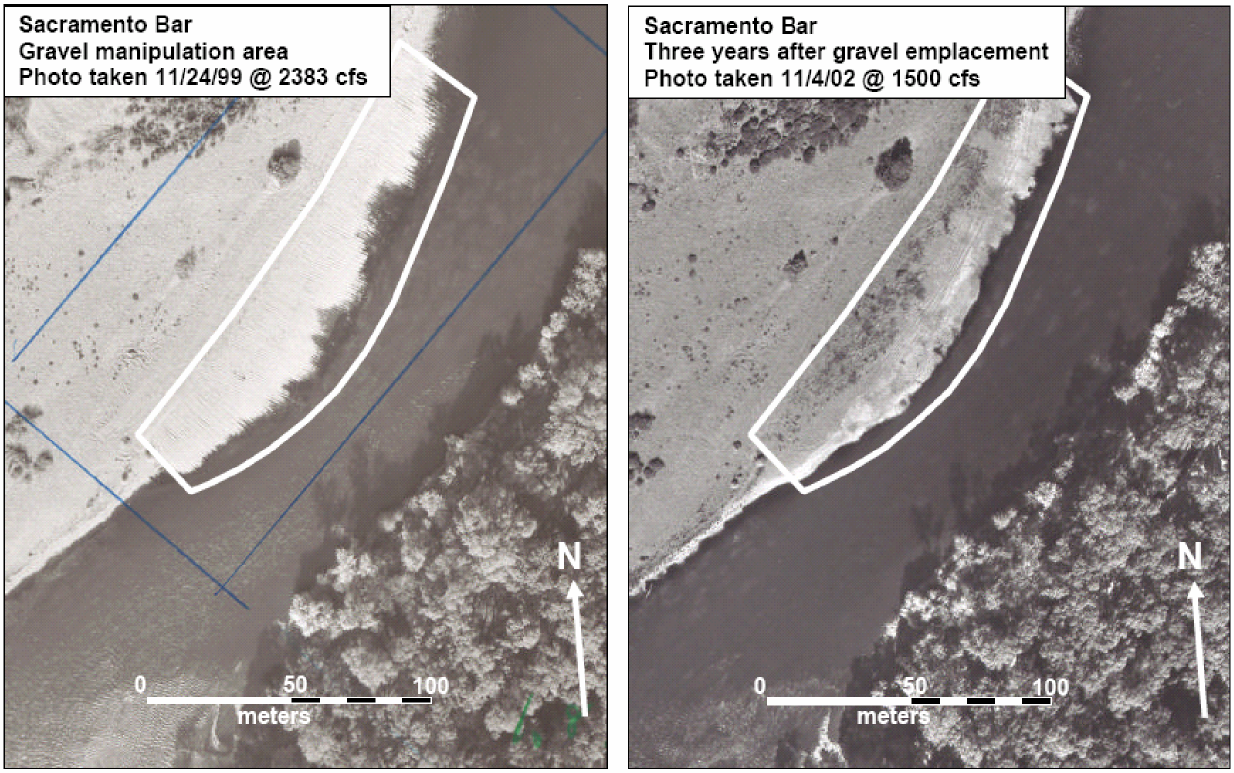

Figure 2. Aerial photographs of Sacaramento Bar, Lower American River (from Horner et al., 2003)

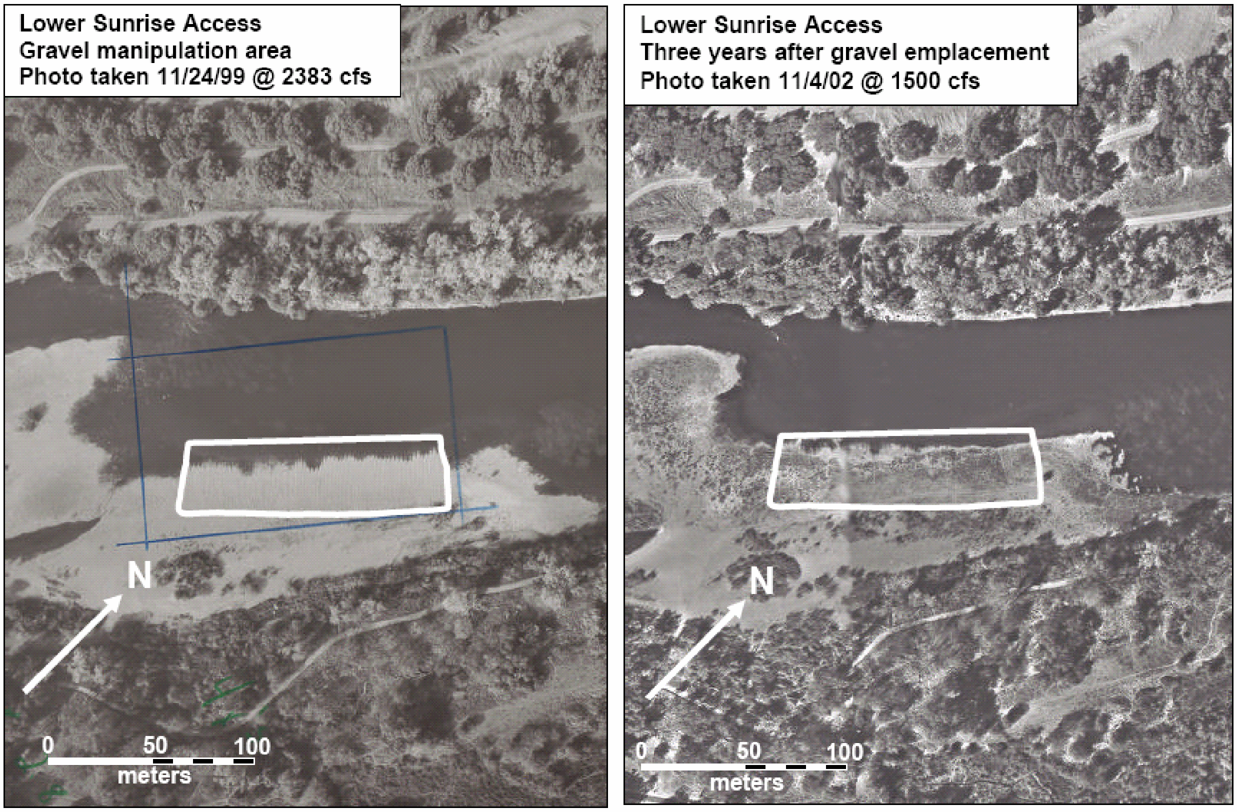

Figure 3. Aerial photographs of Lower Sunrise Access area, Lower American River (from Horner et al., 2003)

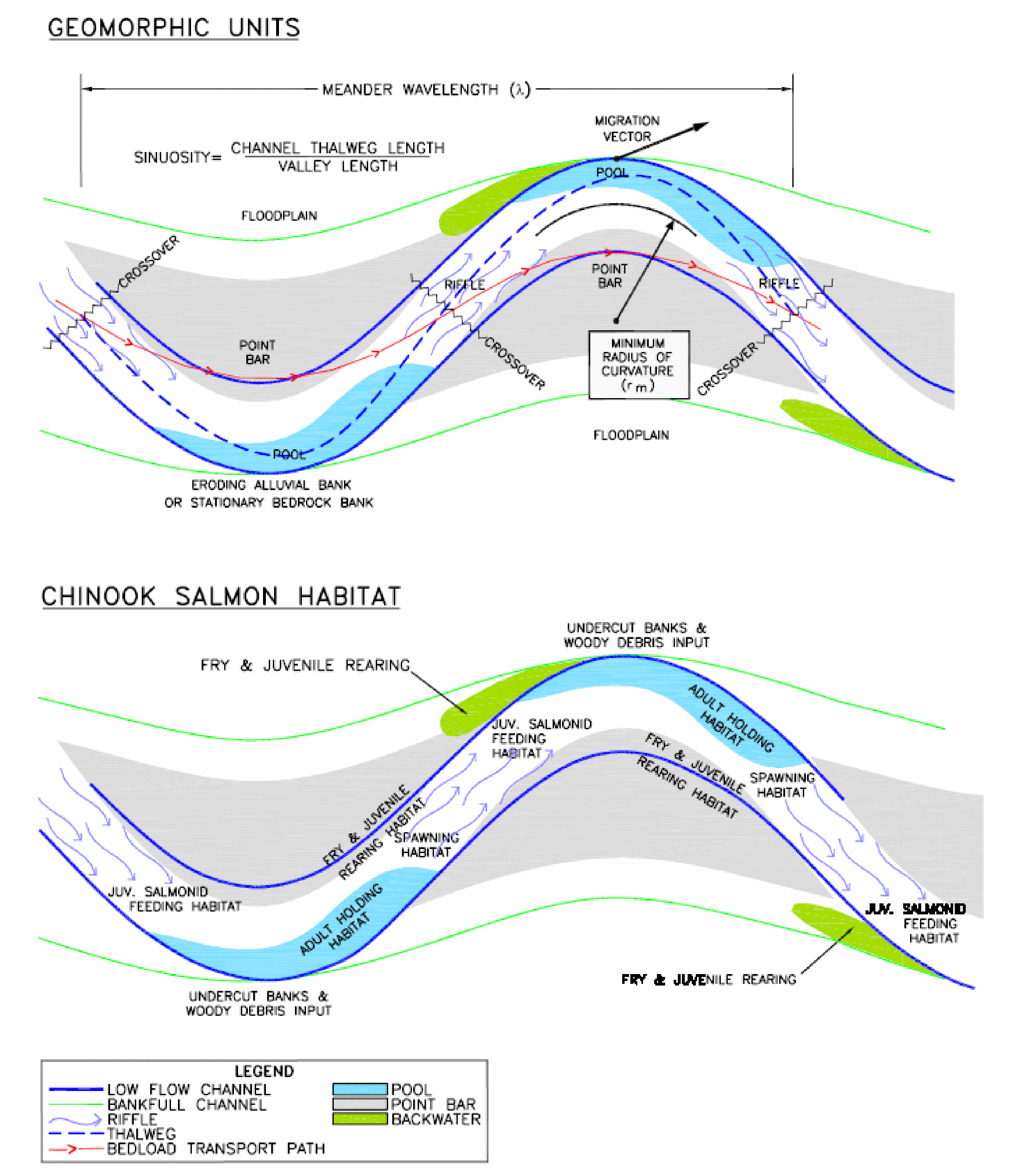

Figure 4. River geomorphology in relation to salmon spawning, holding, and rearing habitat. From: Draft Gravel Augmentation Report, Prepared by the CALFED Science Program and Ecosystem Restoration Program Gravel Augmentation Panel, October 15, 2004.

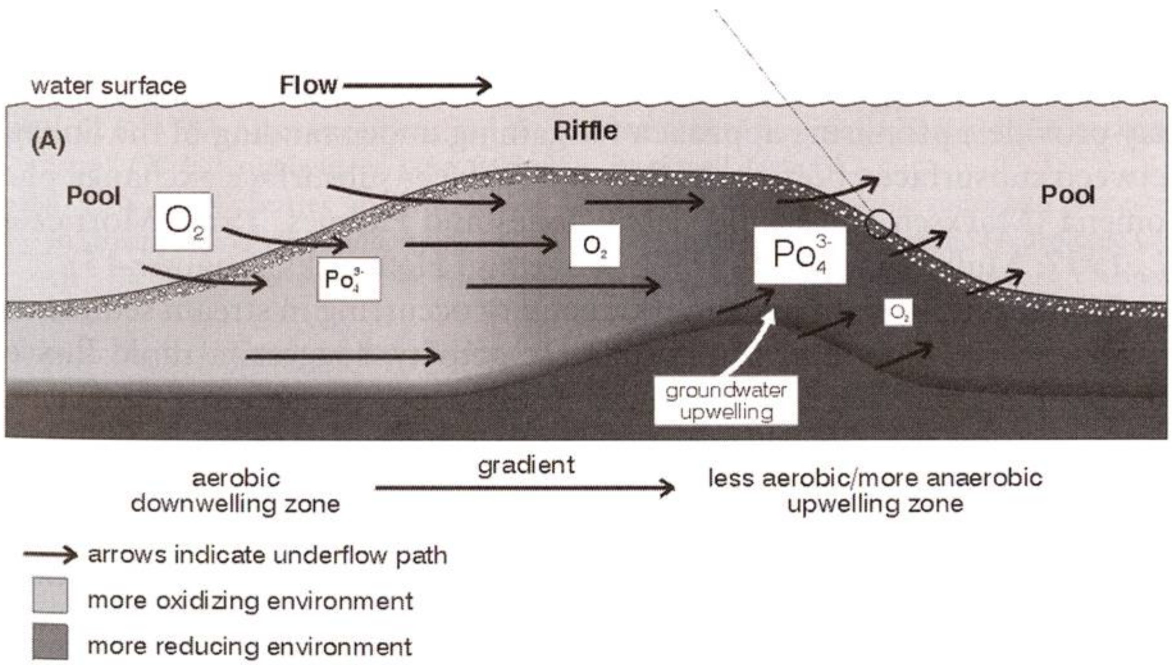

Figure 5: Conceptual model for flow through a pool tailout/riffle sequence. This flow pattern appears to be present in several riffle sequences on the American River. From Jones and Mulholland (2000).

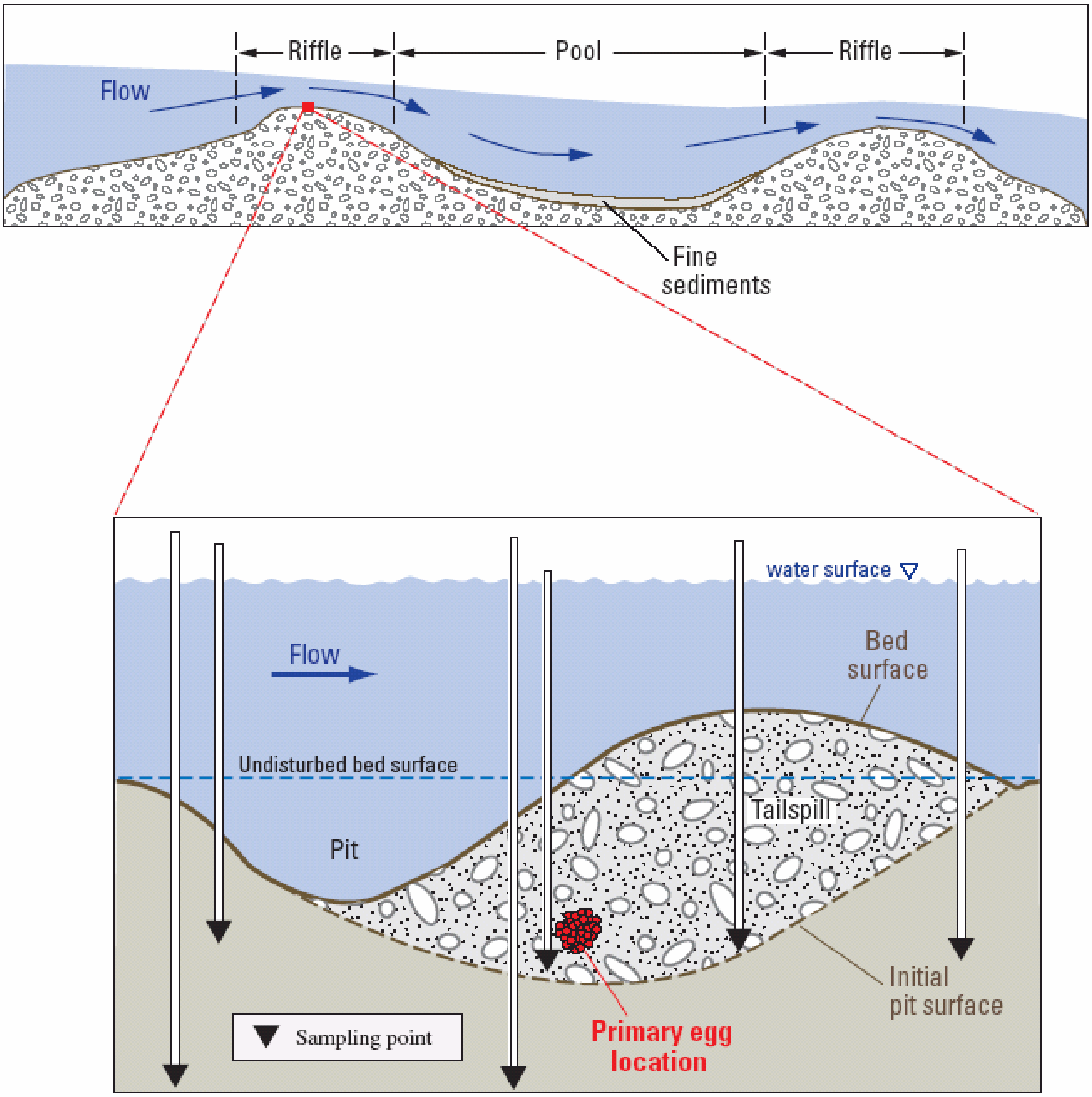

Figure 6. Conceptual model of riffle zone hydrogeology, showing proposed porewater sampling strategy. Lower diagram modified from Evenson (2001).

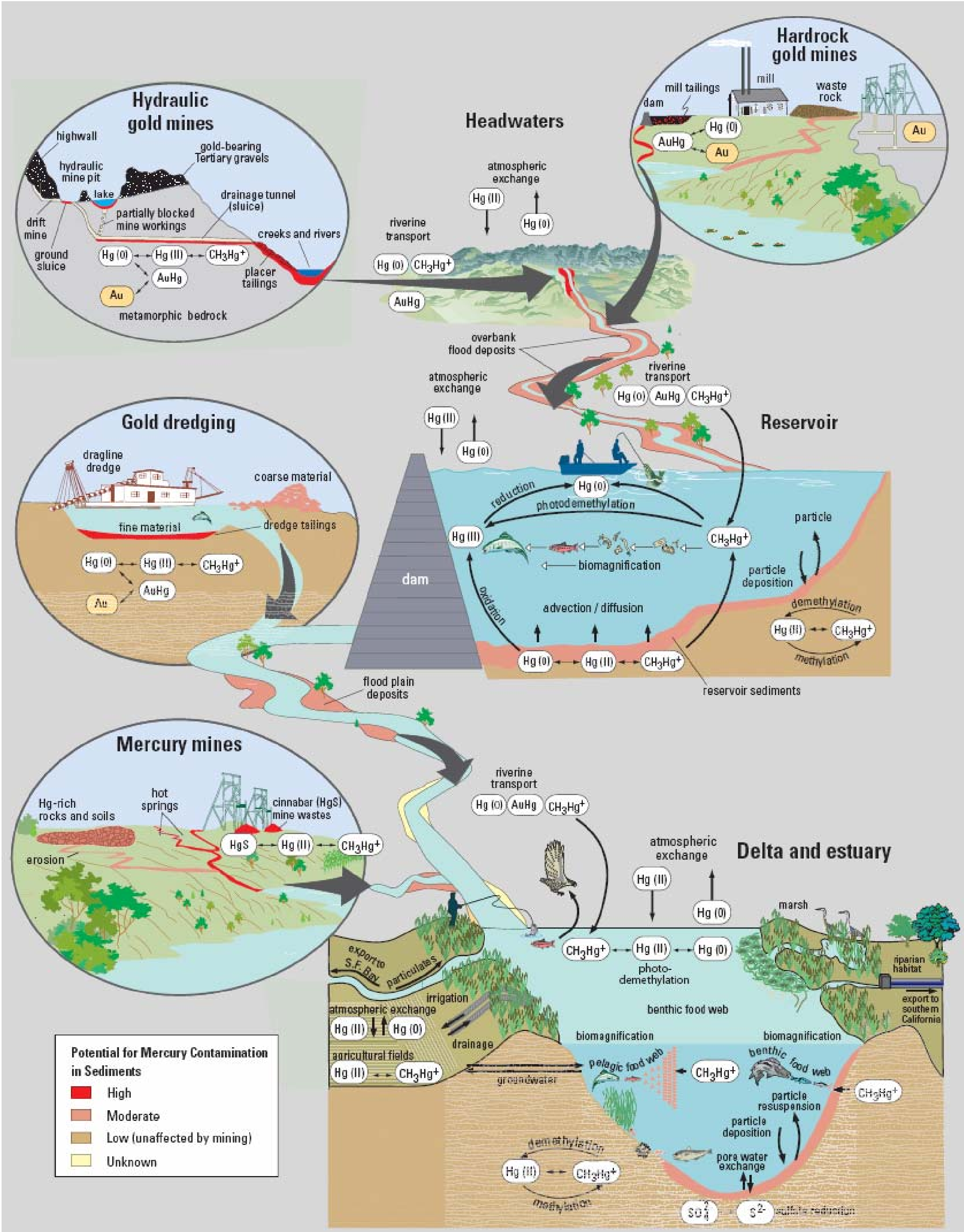

Figure 7. Conceptual model of mercury sources and transport in northern California. Modified from Alpers and Hunerlach (2000) and Wiener et al. (2003).

Lower Sunrise Access
Dissolved oxygen in river water and stream gravel
August 2003 @ 4000 cfs

D.O. at 30 cm depth (mg/L)
D.O. at 60 cm depth (mg/L)
D.O. at 90 cm depth (mg/L)
Stream D.O. = 8.5 mg/L

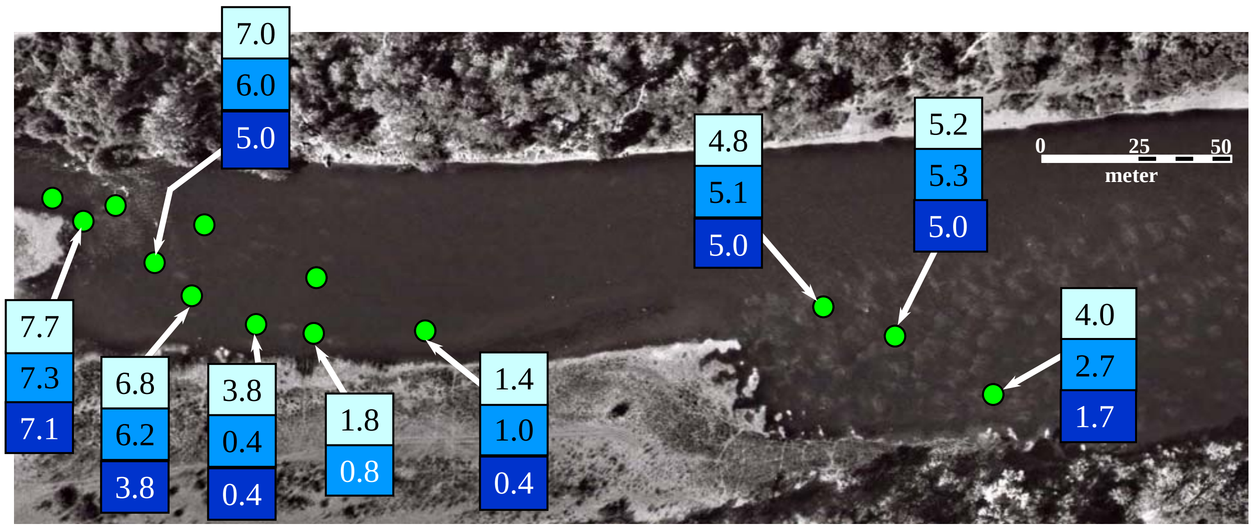

Fig. 8. Lower Sunrise Access area showing dissolved oxygen measurements in hyporheic zone. (from Horner et al., 2003)

Figure 9. Photograph of the freeze-coring process; liquid nitrogen is being poured into a standpipe to freeze a sample of the substrate. (from Evenson, 2001)

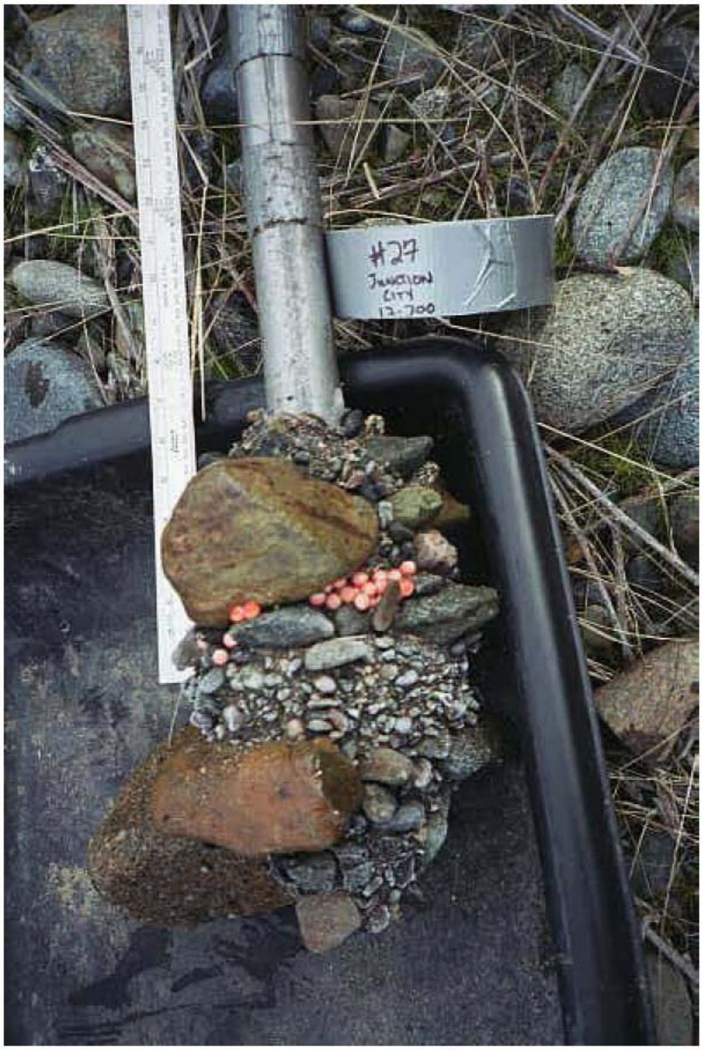

Figure 10. Photograph of a freeze-core sample with exposed chinook eggs, Trinity River, CA, Fall 2000. (from Evenson, 2001)

Tasks And Deliverables

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Task ID	Task Name	Start Month	End Month	Deliverables
1	Project Management	1	36	Semiannual and final progress reports.
2	Physical Characterization of Spawning Redds	1	24	Progress reported in semiannual reports.
3	Water Sampling and Analysis	1	24	Progress reported in semiannual reports.
4	Biological Sampling and Analysis	1	24	Progress reported in semiannual reports.
5	Sediment Sampling and Analysis	1	24	Progress reported in semiannual reports.
6	Data Management and Statistical Analysis	1	36	Draft and final data reports. One Master's thesis at CSU Sacramento and one USGS Data-Series Report are planned.
7	Integration and Reporting	6	36	Draft and final interpretive reports. Two peer-reviewed journal articles are planned.
8	Outreach and Public Involvement	1	36	Presentations at stakeholder meetings and public forums including workshops and symposia. A USGS fact sheet is planned.

Comments

If you have comments about budget justification that do not fit elsewhere, enter them here.

Budget Summary

Project Totals

Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
$108,776	**$25,562**	**$10,625**	**$15,650**	**$576,142**	**$0**	**$0**	**$58,028**	**$794,783**	**$201,524**	**$996,307**

Do you have cost share partners already identified?
No.

If yes, list partners and amount contributed by each:

Do you have potential cost share partners?
No.

If yes, list partners and amount contributed by each:

Are you specifically seeking non−federal cost share funds through this solicitation?
No.

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Year 1 (Months 1 To 12)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And	Other Direct	Direct Total	Indirect Costs	Total

							Rights Of Way	Costs			
1: project management (12 months)	10034	3425	0	400	5912	0	0	4924	$24,695	6245	$30,940
2: Physical Characterization of Spawning Redds (12 months)	0	0	0	0	29185	0	0	0	$29,185	1751	$30,936
3: Water Sampling and Analysis (12 months)	20474	3158	3350	6000	214629	0	0	11719	$259,330	74699	$334,029
4: Biological Sampling and Analysis (12 months)	2461	399	300	500	36705	0	0	2264	$42,629	12936	$55,565
5: Sediment Sampling and Analysis (12 months)	5345	1327	0	0	23027	0	0	2371	$32,070	6652	$38,722
6: Data Management and Statistical Analysis (12 months)	8059	1538	0	0	10655	0	0	3410	$23,662	4718	$28,380
7: Integration and Reporting (7 months)	4900	1375	1200	1000	10581	0	0	3011	$22,067	4237	$26,304
8: Outreach and Public Involvement (12 months)	766	245	0	0	3447	0	0	359	$4,817	636	$5,453

Totals	$52,039	$11,467	$4,850	$7,900	$334,141	$0	$0	$28,058	$438,455	$111,874	$550,329

Year 2 (Months 13 To 24)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
1: project management (12 months)	2617	912	0	200	3022	0	0	1325	$8,076	1766	$9,842
2: Physical Characterization of Spawning Redds (12 months)	0	0	0	0	9184	0	0	0	$9,184	551	$9,735
3: Water Sampling and Analysis (12 months)	17579	2288	3075	4750	120183	0	0	9839	$157,714	47004	$204,718
4: Biological Sampling and Analysis (12 months)	2017	712	300	0	36705	0	0	1076	$40,810	12366	$53,176
5: Sediment Sampling and Analysis (12 months)	4009	1356	0	0	18337	0	0	1906	$25,608	5815	$31,423
6: Data Management and Statistical Analysis (12 months)	7943	2104	0	0	9364	0	0	3569	$22,980	4832	$27,812
	6762	1955	1200	500	25210	0	0	3701	$39,328	5940	$45,268

7: Integration and Reporting (12 months)											
8: Outreach and Public Involvement (12 months)	**766**	**245**	**0**	**0**	**3447**	**0**	**0**	**359**	$4,817	**579**	$5,396
Totals	**$41,693**	**$9,572**	**$4,575**	**$5,450**	**$225,452**	**$0**	**$0**	**$21,775**	**$308,517**	**$78,853**	**$387,370**

Year 3 (Months 25 To 36)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
1: project management (12 months)	**2617**	**912**	**0**	**100**	**2890**	**0**	**0**	**1290**	$7,809	**1716**	$9,525
6: Data Management and Statistical Analysis (12 months)	**2986**	**798**	**0**	**200**	**3623**	**0**	**0**	**1415**	$9,022	**1910**	$10,932
7: Integration and Reporting (12 months)	**7910**	**2323**	**1200**	**1000**	**6589**	**0**	**0**	**4417**	$23,439	**5680**	$29,119
8: Outreach and Public Involvement (12 months)	**1531**	**490**	**0**	**1000**	**3447**	**0**	**0**	**1073**	$7,541	**1491**	$9,032
Totals	**$15,044**	**$4,523**	**$1,200**	**$2,300**	**$16,549**	**$0**	**$0**	**$8,195**	**$47,811**	**$10,797**	**$58,608**

Budget Justification

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Labor

YEAR 1 hourly Task 1 hours rate total Alpers 80 $50.43 $4,034 Hunerlach 200 $30.00 $6,000

Task 2 0

Task 3 Alpers 104 $50.43 $5,245 Hunerlach 88 $30.00 $2,640 Hydrologic Technician 520 $24.21 $12,589

Task 4 Alpers 20 $50.43 $1,009 Hydrologic Technician 60 $24.21 $1,453

Task 5 Alpers 20 $50.43 $1,009 Hunerlach 80 $30.00 $2,400 Hydrologic Technician 80 $24.21 $1,937

Task 6 Alpers 40 $50.43 $2,017 Hydrologist 200 $24.21 $4,842 Hunerlach 40 $30.00 $1,200

Task 7 Alpers 40 $38.28 $1,531 Hydrologist 40 $24.21 $968 Hunerlach 80 $30.00 $2,400

Task 8 Alpers 20 $38.28 $766

YEAR 2 hourly Task 1 hours rate total Alpers 40 $50.43 $2,017 Hunerlach 20 $30.00 $600

Task 2 0

Task 3 Alpers 80 $50.43 $4,034 Hunerlach 48 $30.00 $1,440 Hydrologic Technician 500 $24.21 $12,105

Task 4 Alpers 40 $50.43 $2,017

Task 5 Alpers 20 $50.43 $1,009 Hunerlach 100 $30.00 $3,000

Task 6 Alpers 50 $50.43 $2,522 Hydrologist 100 $24.21 $2,421 Hunerlach 100 $30.00 $3,000

Task 7 Alpers 120 $38.28 $4,594 Hydrologist 40 $24.21 $968 Hunerlach 40 $30.00 $1,200

Task 8 Alpers 20 $38.28 $766

YEAR 3 hourly Task 1 hours rate total Alpers 40 $50.43 $2,017 Hunerlach 20 $30.00 $600

Task 2 0

Task 3 0

Task 4 0

Task 5 0

Task 6 Alpers 40 $50.43 $2,017 Hydrologist 40 $24.21 $968

Task 7 Alpers 150 $38.28 $5,742 Hydrologist 40 $24.21 $968 Hunerlach 40 $30.00 $1,200

Task 8 Alpers 40 $38.28 $1,531

Benefits

Hourly benefit rate Alpers (Research Chemist) $17.81 Hunerlach (Geologist) $10.00 Hydrologist $ 2.13 Hydrologic Technician $ 2.13

Travel

YEAR 1 Travel purpose Travel cost Task 1 $0 Task 2 $0 Task 3 Local, to field site $3,350 Task 4 Local, to field site $300 Task 5 $0 Task 6 $0 Task 7 Attend scientific meeting $1,200 Task 8 $0

YEAR 2 Travel purpose Travel cost Task 1 $0 Task 2 $0 Task 3 Local, to field site $3,075 Task 4 Local, to field site $300

Task 5 $0 Task 6 $0 Task 7 Attend scientific meeting $1,200 Task 8 $0

YEAR 3 Travel purpose Travel cost Task 1 $0 Task 2 $0 Task 3 $0 Task 4 $0 Task 5 $0 Task 6 $0 Task 7 Attend scientific meeting $1,200 Task 8 $0

Supplies And Expendables

YEAR 1 Office Computer Field Total Supplies Supplies Supplies Supplies Task 1 $200 $200 $400 Task 2 $0 Task 3 $6,000 $6,000 Task 4 $500 $500 Task 5 $0 Task 6 $0 Task 7 $500 $500 $1,000 Task 8 $0 YEAR 2 Office Computer Field Total Supplies Supplies Supplies Supplies Task 1 $100 $100 $200 Task 2 $0 Task 3 $4,750 $4,750 Task 4 $0 Task 5 $0 Task 6 $0 Task 7 $250 $250 $500 Task 8 $0 YEAR 3 Office Computer Field Total Supplies Supplies Supplies Supplies Task 1 $100 $100 Task 2 $0 Task 3 $0 Task 4 $0 Task 5 $0 Task 6 $200 $200 Task 7 $500 $500 $1,000 Task 8 $1,000 $1,000

Office Computer Field Total Supplies Supplies Supplies Supplies YEAR 1 $700 $700 $6,500 $7,900 YEAR 2 $350 $350 $4,750 $5,450 YEAR 3 $1,500 $800 $0 $2,300 Grand Totals $2,550 $1,850 $11,250 $15,650

Services And Consultants

1) Dr. Timothy Horner of CSU Sacramento (CSUS) is considered a co-principal investigator on this project. He and his group will be involved in all tasks of the project during all years. The year-by-year total cost for involvement of the CSUS group under Dr. Horner's supervision will be as follows: Year 1 $101,040 Year 2 $ 70,353 Year 3 $ 16,549 -------- Total $187,942 Detailed costs for his group's activities are provided below for each year and each task of the project. The mechanism for transferring funds from USGS to CSUS will be by cooperative agreement. The USGS special overhead rate of 6% for pass-throughs of this kind should apply.

a. CSUS Labor and Benefits YEAR 1 hours hourly total benefit total rate labor rate benefits Horner 600 $39.57 $23,742

$12.66 $7,597 Graduate Students 1300 $15.00 $19,500 $1.80 $2,340 Student Assistant 650 $12.00 $7,800 $1.50 $975

YEAR 2 hours hourly total benefit total rate labor rate benefits Horner 460 $39.57 $18,202 $12.66 $5,825 Graduate Student 1000 $15.00 $15,000 $1.80 $1,800 Student Assistant 280 $12.00 $3,360 $1.50 $420

YEAR 3 hours hourly total benefit total rate labor rate benefits Horner 110 $39.57 $4,353 $12.66 $1,393

b. CSUS Travel YEAR 1 Local Travel (tasks 2, 3, 4, 5) $3,130 Travel to meeting (task 7) $1,200

YEAR 2 Local Travel (tasks 2, 3, 4, 5) $1,480 Travel to meeting (task 7) $1,200

YEAR 3 Travel to meeting (Task 7) $1,200

c. CSUS Supplies and Expendables YEAR 1 Field supplies $8,000 Office supplies $1,000 Computer supplies $ 800

YEAR 2 Field supplies $5,000 Office supplies $ 500 Computer supplies $ 600

YEAR 3 Field supplies $ 0 Office supplies $ 600 Computer supplies $ 500

d. CSUS Indirect Costs The CSUS overhead rate is 32%, applied to the net costs. YEAR 1 $24,494 YEAR 2 $17,055 YEAR 3 $ 4,012 ------- total $45,562

2) Dr. Darell Slotton at UC Davis (UCD) will collaborate on Task 4 of the project (Biological Sampling and Analysis). Dr. Slotton and his colleagues at UCD will be responsible for sampling macroinvertebrates at up to five sites in the lower American River during two consecutive years, and for analyzing total mercury and methylmercury in biological samples including macroinvertebrtates and early life stages of fall-run Chinook salmon (to be samples by USGS and CSUS with assistance from the California Department of Fish and Game and

the Burueau of Reclamation).The cost of the work by Dr. Slotton and colleagues will be as follows: Year 1 $30,000 Year 2 $30,000 Year 3 $ 0 ------- Totals $60,000 The mechanism for transferring funds from USGS to UCD will be by cooperative agreement. The USGS special overhead rate of 6% for pass-throughs of this kind should apply.

3) Laboratory Costs

a. The USGS Wisconsin District Mercury Laboratory (WDML) in Middleton, WI will provide analyses of mercury and methylmercury in water and sediment for Tasks 3 and 5 of the project. Costs are anticipated as follows: YEAR 1 Task 3 $94,250 (377 water samples at $250 for methyl and total mercury) Task 5 $ 6,000 (24 sediment samples at $250 for methyl and total mercury) YEAR 2 Task 3 $55,250 (221 water samples at $250 for methyl and total mercury) Task 5 $ 6,000 (24 sediment samples at $250 for methyl and total mercury)

b. The USGS National Research Program laboratory in Boulder, CO will analyze trace metals, major cations, and major anions in water samples, and trace metals in sediment samples as part of Tasks 3 and 5. The following costs are anticipated: YEAR 1 Task 3 $56,500 (377 water samples at $150) Task 5 $ 3,600 (24 sediment samples at $150) YEAR 2 Task 3 $33,150 (221 water samples at $150) Task 5 $ 3,600 (24 sediment samples at $150)

c. The USGS National Water Quality Laboratory (NWQL) in Boulder, CO will analyze nutrients (various forms of nitrogen and phosphorous) and organic carbon in filtered water samples. The expected costs are: YEAR 1 Task 3 $37,700 (377 water samples at $100) YEAR 2 Task 3 $22,100 (221 water samples at $100)

d. A laboratory to be deterimined will analyze hormones in fish tissue (eggs, alevins and fry) as part of Task 4. The total costs will be: YEAR 1 $5,000 YEAR 2 $5,000

Equipment

none

Lands And Rights Of Way

none

Other Direct Costs

Other Direct Costs are mandatory assessments imposed by USGS in four categories: 1) Reports and Illustration Support (7%) 2) Project Contingencies (5.35%) 3) Science Program Support (7.03%) 4) District Infrastructure and Support (16.15%) The total of these assessments is 35.53%. Percentage rates listed above are applied to net costs (such as labor, travel, supplies, etc.) prior to computation of overhead.

An explanation of each category follows. 1) Reports and Illustator Support funds personnel to edit products and prepare illustrations for products and associated costs. 2) Project Contingencies covers time delays and other unforseen circumstances that add additional costs to the project. 3) Science Program Support funds support of Program Chiefs, database management, and other science support staff. 4) District Infrastructure and Support funds support of IT, enterprise software, Discipline Specialists, Management, Administrative support, and Cost Center Capital Investment.

Indirect Costs/Overhead

The indirect rate used to compute indirect costs in this proposal is 31.36%. This rate is composed of three mandatory assessments (applied as a percentage of gross funding): Bureau Assessment (BOTSC) − 9.69 % District Assesment (DOTSC) − 11.76 % Reimbursable Facilities Assessment − 9.91 %

The following narrative explains USGS policy on cost recovery, including the breakdown of charges between direct and indirect costs.

U.S. Geological Survey Policy on Cost Recovery

U.S. Geological Survey (USGS), as is the case with all Federal agencies, is required by law and implementing Office of Management and Budget (OMB) Circulars to recover the full costs incurred for the provision of products and services to customers when doing work on a reimbursable basis. Customers include Federal agencies; State, local and tribal governments; territories; non-profit organizations; foreign countries; private entities; and the general public.

The USGS recovers full costs by charging non-USGS customers both direct and indirect costs. Direct costs are costs that can be specifically identified with producing a particular product or providing a service. Indirect costs are costs that cannot be specifically identified with an individual product or service, but which support the delivery of reimbursable services and products. Indirect costs include executive, managerial, supervisory, administrative, and financial functions and related systems at all levels of the bureau, as well as costs incidental to providing services and products such as postage, training, miscellaneous supplies and materials, etc. Indirect costs are charged to non-USGS customers through use of a bureau rate (to recover bureau, Headquarters, and Regional level indirect costs) and a cost center common services rate (to recover cost center level indirect costs) applied to the direct costs incurred to provide products and services.

In recovering full costs (both direct and indirect), applicable laws and implementing regulations do not permit agencies to undercharge or excuse a customer from paying the full costs. Consequently, USGS has no legal authority to waive or reduce the recovery of both direct and indirect costs, nor does it have authority to increase the amount of costs charged to some customers because other customers were not charged full costs. Therefore, special rates may only be applied when USGS can demonstrate that indirect costs are substantially and consistently less than the norm. Also, when there is legislative authority, USGS programs may share costs with customers when appropriate to the science and program

priorities (e.g., cooperative programs, biology cost share, etc.).

Comments

Environmental Compliance

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

CEQA Compliance

Which type of CEQA documentation do you anticipate?
X none
− negative declaration or mitigated negative declaration
− EIR
− categorical exemption

If you are using a categorical exemption, choose all of the applicable classes below.
− Class 1. Operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" itemized above are not intended to be all−inclusive of the types of projects which might fall within Class 1. The key consideration is whether the project involves negligible or no expansion of an existing use.
− Class 2. Replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced.
− Class 3. Construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. The numbers of structures described in this section are the maximum allowable on any legal parcel, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
− Class 4. Minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry or agricultural purposes, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
− Class 6. Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies. These 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.
− Class 11. Construction, or placement of minor structures accessory to (appurtenant to) existing commercial, industrial, or institutional facilities, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.

Identify the lead agency.

Is the CEQA environmental impact assessment complete?

If the CEQA environmental impact assessment process is complete, provide the following information about the resulting document.

Document Name
State Clearinghouse Number

If the CEQA environmental impact assessment process is not complete, describe the plan for completing draft and/or final CEQA documents.

NEPA Compliance

Which type of NEPA documentation do you anticipate?
X none
− environmental assessment/FONSI
− EIS
− categorical exclusion

Identify the lead agency or agencies.

If the NEPA environmental impact assessment process is complete, provide the name of the resulting document.

If the NEPA environmental impact assessment process is not complete, describe the plan for completing draft and/or final NEPA documents.

Successful applicants must tier their project's permitting from the CALFED Record of Decision and attachments providing programmatic guidance on complying with the state and federal endangered species acts, the Coastal Zone Management Act, and sections 404 and 401 of the Clean Water Act.

Please indicate what permits or other approvals may be required for the activities contained in your proposal and also which have already been obtained. Please check all that apply. If a permit is *not* required, leave both Required? and Obtained? check boxes blank.

Local Permits And Approvals	Required?	Obtained?	Permit Number (If Applicable)
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	Required?	Obtained?	Permit Number (If Applicable)
scientific Collecting Permit	X	–	
CESA Compliance: 2081	–	–	
CESA Complance: NCCP	–	–	
1602	–	–	
CWA 401 Certification	–	–	
Bay Conservation And Development Commission Permit	–	–	
reclamation Board Approval	–	–	
Delta Protection Commission Notification	–	–	
state Lands Commission Lease Or Permit	–	–	

action Specific Implementation Plan	–	–	
other	–	–	

Federal Permits And Approvals	Required?	Obtained?	Permit Number (If Applicable)
ESA Compliance Section 7 Consultation	–	–	
ESA Compliance Section 10 Permit	–	–	
Rivers And Harbors Act	–	–	
CWA 404	–	–	
other	–	–	

Permission To Access Property	Required?	Obtained?	Permit Number (If Applicable)
permission To Access City, County Or Other Local Agency Land Agency Name	–	–	
permission To Access State Land Agency Name	–	–	
permission To Access Federal Land Agency Name Bureau Of Reclamation	X	X	
permission To Access Private Land Landowner Name	–	–	

If you have comments about any of these questions, enter them here.

Land Use

Comparison of hyporheic water quality and methylmercury exposure in salmonid redds within restored and unrestored gravels in the lower American River

Does the project involve land acquisition, either in fee or through easements, to secure sites for monitoring?
X No.
– Yes.

How many acres will be acquired by fee?

How many acres will be acquired by easement?

Describe the entity or organization that will manage the property and provide operations and maintenance services.

Is there an existing plan describing how the land and water will be managed?
– No.
– Yes.

Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?
X No.
– Yes.

Describe briefly the provisions made to secure this access.

Do the actions in the proposal involve physical changes in the current land use?
X No.
– Yes.

Describe the current zoning, including the zoning designation and the principal permitted uses permitted in the zone.

Describe the general plan land use element designation, including the purpose and uses allowed in the designation.

Describe relevant provisions in other general plan elements affecting the site, if any.

Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?
X No.
– Yes.

Land Designation	Acres	Currently In Production?
Prime Farmland		**–**
Farmland Of Statewide Importance		**–**
Unique Farmland		**–**
Farmland Of Local Importance		**–**

Is the land affected by the project currently in an agricultural preserve established under the Williamson Act?
X No.
– Yes.

Is the land affected by the project currently under a Williamson Act contract?
X No.
– Yes.

Why is the land use proposed consistent with the contract's terms?

Describe any additional comments you have about the projects land use.