Draft Individual Review Form

Proposal number: 2001-F201-1 **Short Proposal Title: Microbial community & Se management**

1a) Are the objectives and hypotheses clearly stated?
Objectives are clearly but broadly stated. Statements of hypotheses are somewhat garbled.

1b1) Does the conceptual model clearly explain the underlying basis for the proposed work?
Yes. Microbiological communities will be sampled at unspecified depths in the water column at an unspecified number of locations in the San Luis Drain, Mud Slough and the San Joaquin River. The number of replicates is not given. The micro-biota in these samples will be characterized as to community structure, function, dynamics and seasonal and spatial variation. It is not stated how the solution phase at each site will be physically and chemically characterized. An unspecified number of microorganisms will be isolated from the samples and identified by a 96-chamber respiration system. Communities of organisms in the samples will also be characterized by the system as a fingerprint of responses. "Collateral data" on "system operating parameters" will be collected, archived and quantitatively related to community response. It is suggested that these latter results can be used to make decisions about operation of the aquatic system (San Joaquin River Basin). Given the results of selenium speciation in micro-biota samples, a feeding study will be carried out using red swamp crayfish and mosquito fish. The food will be either selected species of pure selenium compounds or bacterial biomass produced by culture of isolates. Another objective of the proposal is to study and either remediate or prevent biofouling of conductivity and oxygen sensors. This subset of the study is justified because it is believed that the fouling is due to microbiota. The aquatic system conditions at the time of biofouling will be observed and the causative agent will be identified. Further studies will test techniques to remediate or prevent the problem.

1b2) Is the approach well designed and appropriate for meeting the objectives of the project?
The approach to identifying microbial species and characterizing microbial communities in samples appears to be very well designed and appropriate for those objectives. The approach to identifying and quantifying species of selenium in the samples appears appropriate in theory but may have severe difficulties in practice. The number of samples is not given but a very large number will be required. Some of the analyses will apparently be carried out by GC-MS at Davis. It is questionable whether that laboratory will have sufficient resources to handle the sample load. Some of the selenium speciation including especially the analysis of elemental selenium is to be carried out by XANES. Whereas this is an elegant speciation technique, it suffers from high demand and low availability. Usually, investigators must limit themselves to carefully designed experiments where a small number of analyses can adequately test one or very few hypotheses. Since this portion of the proposal is essentially a survey, by its nature it will involve a large number of samples which will likely exceed the available beam time. It is not clear whether the investigators plan to measure rates of volatile selenium production at each sampling at each site. The feeding experiments will produce selenium transfer coefficients, but it will not be possible to extend these results to predict ecotoxic hazard to the list of endemic predator consumers. This would be more directly achieved by field capture and analysis for levels of selenium species in the crayfish and the fish. Another objective is to use the community-level physiological profile (CLPP) to produce a multidimensional profile of the community which will then be compared to "collateral data on system operating parameters". Since these will be field observations (not tightly controlled treatment plants) there will be a large variability in the collateral data which will make it very difficult to associate any one change or combination of changes in water quality as the cause for observed changes in community performance or composition. In principle, this might be sorted out if the observations were continued for 10 to 15 years but experience with wild ecosystems

suggests it cannot be done with any confidence in one or two years. Thus the objective of using CLPP as a near real-time SJRB hydrologic management tool almost certainly cannot be achieved within the time frame of this proposal.

1c1) Has the applicant justified the selection of research, pilot or demonstration project, or a full-scale implementation project?
The investigators do not address the issue but the proposal appears to be almost completely research except for application of results to improvement in management of the demonstration facility for bacterial selenium removal from agricultural drain waters at the Panoche Water District.

1c2) Is the project likely to generate information that can be used to inform future decision making?
If the sensor biofouling problem is resolved, system managers will have more confidence in electrical conductivity and dissolved oxygen measurements. "Collateral measurements" at each of the sampling sites will be useful in describing system performance both in the water delivery system and in the San Joaquin River. It is unlikely that the CLPP methodology can be reliably used by decision-makers given the short time span of this project.

2a) Are the monitoring and information assessment plans adequate to assess the outcome of the project?
This project does not manipulate any part of the system. This version of the proposal has so few details about numbers of samples, location of sampling and "collateral measurements" that it is difficult to judge.

2b) Are data collection, data management, data analysis, and reporting plans well-described, scientifically sound and adequate to meet the proposed objectives?
The major question is the quantity of data that will be generated. The investigators properly note that data will be delivered only after their quality and accuracy have been confirmed. The short description of statistical treatment suggests reasonable and appropriate techniques will be applied. The number of reports is also reasonable.

3) Is the proposed work likely to be technically feasible?
The sampling, microbial identification, community characterization, selenium speciation, food chain transfer study and the biofouling studies are all technically feasible.

4) Is the proposed project team qualified to efficiently and effectively implement the proposed project?
The team clearly has the expertise to identify bacterial isolates and to characterize micro-biotic communities as well as to identify selenium species in or associated with the communities. The animal feeding project is also likely to be executed appropriately. One of the aspects that is questionable is the measurement of the properties of each of the sampled locations. One of the reasons for this question is that almost no details are given except the very vague phrase "collateral measurements". One of the assumptions implicit in the proposal is that species capabilities are the dominant control over selenium transformation. Clearly, there are environmental conditions which affect transformation. For instance, selenium acquisition from solution can be quite different for selenate vs. selenite vs. low molecular weight organic selenium compounds. There is no indication in the proposal that the solution phase at each site will be thus characterized. In fact, selenate is often not measured in many of the publications of the team and there seems to be a predilection by members of the team to use selenite in experimentation even though it has frequently been shown that selenate is the dominant inorganic species in oxic alkaline solution. The literature has also shown that selenate is competitive with sulfate for absorption by both micro-and macro-phytes. Another factor which exercises significant control is available energy. Whereas direct measurement of this is difficult, redox potential is a useful surrogate especially in the sediment. There is no indication in the proposal that Eh will be measured at each site. In regard to the approach to the

biofouling problem, the investigators will certainly identify the species of organisms causing the biofouling. The proposal recites information about biofouling in water treatment systems but does not clearly indicate how this information will be applied to remediation of the problem in the field. It is significant that the proposal does not discuss the physical attributes of either conductivity or oxygen sensors. One of the proposals for the conductivity sensors is to coat them. This would require that the coating conduct electrons. Fouling of electro-chemical sensors in the field has been prevented by enclosing them in porcelain with pores fine enough to exclude microorganisms. Most conductivity sensors are constructed of noble metals such as platinum, gold or palladium and as a consequence will tolerate very corrosive conditions. It is possible that the fouling organisms could be discouraged by application of high voltage at an optimum frequency, neither of which would damage the electrodes. Such an approach would not be appropriate for oxygen sensors. The usual design of these devices is to measure the current at an electrode which is reducing oxygen gas to hydroxide. The electrodes reside in a cavity filled with an electrolyte solution or gel which is separated from the aqueous sample by a gas permeable membrane. It should be possible to mix into the gel an electro-inactive micro-biocide with properties that would permit it to diffuse through the membrane into the critical region where the organisms might attach and cause biofouling. Although these are obvious approaches, they are not mentioned in the proposal.

Miscellaneous comments

Overall Evaluation **Provide a brief explanation of your summary rating**
Summary Rating

- ☐ Excellent
- ☐ Very Good
- ☐ Good **XXX**
- ☐ Fair
- ☐ Poor

Almost none of the very extensive literature on selenium behavior in aquatic systems is cited in this proposal. From this literature it is clear that aquatic microorganisms are universally capable as a group of transferring selenium into sediments and into the atmosphere. This proposal will expand our scientific knowledge of the capabilities of particular microbial species to carry out these transformations but the proposal is overly optimistic about extending this knowledge into basin management tools. The proposal gives extensive detail in respect to some techniques but virtually nothing about characterizing the overall state of the sampling sites at each sampling date.