INTERAGENCY ECOLOGICAL PROGRAM

Environmental Monitoring Program

EMP REVIEW CORE TEAM RESPONSE TO THE 2002 IEP SCIENCE ADVISORY GROUP REVIEW OF THE EMP

Final Version

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Summary

The Interagency Ecological Program (IEP) Science Advisory Group (SAG) provided an independent scientific review of the IEP Environmental Monitoring Program (EMP) as part of this program's 2001-2002 comprehensive programmatic review. Here, the EMP review core team (expanded to include Wim Kimmerer) provides a written response to the SAG review dated May 22, 2002.

The EMP review core team greatly appreciates the SAG's constructive criticism and overall enthusiastic support of the program, the ongoing review, and the main recommendation resulting from the 2001-2002 review process, namely the shift in program emphasis from discrete to continuous monitoring. The core team is particularly thankful for SAG comments regarding the basis for the EMP. These comments led the core team to an intense and productive exploration of program aims and the conceptual basis for the EMP sampling design, yielding what the core team believes is a much improved basis for the program and sampling design.

As its "primary recommendation," the SAG called for the EMP to focus on rapidly turning data into useful products by increasing the program's human intellectual investment and working with outside researchers. The EMP review core team fully agrees with this assessment, and the first substantial steps toward addressing this issue have already been taken. A more fundamental criticism concerned the lack of program aims and specific questions "germane to the initial reasons for initiating the program" and guiding its design, and a lack of synthesis among program elements. The EMP review core team agreed with this assessment and in response developed a hierarchy of aims consisting of (1) the fundamental program goal based on the legal mandate for the EMP and the IEP mission, (2) program objectives based on current information needs that are intended to guide the program's design, and (3) specific questions leading to specific information products for resource managers, researchers, and the interested public.

The overall conceptual model associated with the program objectives and design should be based on our current understanding of system hydrodynamics, geometry, and ecology. This leads us to propose an EMP sampling design organized around "ambient" stations whose locations are chosen to represent regional ambient conditions and "flux" stations whose locations are placed at critical points within the major flow paths in the system. Our ultimate goal is to locate continuous monitoring stations within a tidal excursion of neighboring stations throughout the upper estuary and near important geometric features (sills, cells) in the deeper, western part of the estuary to enable data analysis at the relevant transport time scales. Discrete sampling for other water quality and phytoplankton constituents would take place during continuous station maintenance. The spatial structure of discreetly sampled constituents would also be estimated based on knowledge of tidal excursions and local processes. We hope that the combination of flux measurements and estimates of spatial structures will lead to improved information about the system as a whole, including better assessments of the impact of water project operations. Stations should coincide as much as possible with historical EMP stations to preserve program continuity. We also propose more comprehensive data analyses and more similar sampling designs for all program elements to achieve better program synthesis.

The SAG review found that two EMP elements, phytoplankton and benthos monitoring, lack program direction and convincing procedures. The EMP review core team proposes action plans to address these problems. These plans include the creation of an IEP Benthic Estuarine Ecology Team (BEET) as a forum to discuss outstanding issues such as uncertainties about program goals, and guide studies for the redesign of the benthos monitoring element.

Finally, individual SAG members made numerous valuable recommendations for program improvement. Responses to these recommendations, as well as summaries of the core team's responses to the general SAG recommendations, are provided in Tables.

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I. NARRATIVE RESPONSE

Introduction

During 2001-2002, the Interagency Ecological Program (IEP) Environmental Monitoring Program (EMP) was scheduled to undergo a comprehensive programmatic review[1]. The review was conducted by a core group of agency scientists, invited technical experts working in four subject area teams (SATs), stakeholder representatives participating in three all-participant meetings, and the IEP Science Advisory Group (SAG). This document contains the response of the review core team (expanded to include Wim Kimmerer) to the written SAG review dated May 22, 2002.

Overall, the SAG applauded the EMP for its consistent and comprehensive long-term monitoring efforts spanning more than three decades. These efforts have produced invaluable monitoring data for one of the most highly impacted estuaries in the nation. SAG members also endorsed and supported the scope and design of the 2001-2002 programmatic review and agreed with the main recommendation resulting from the 2001-2002 review process, namely the shift in program emphasis from discrete to continuous monitoring.

The SAG prefaced its recommendations by pointing out two important program review constraints: the legal mandate of the program which renders major structural changes inappropriate, and the program's fixed resources which limit substantial expansions in scale and scope.

EMP response regarding constraints

We agree with the SAG's assessment of EMP review constraints. The legal mandate for the EMP is based on Water Right Decision 1641. This Decision received final approval from the State Water Resources Control Board in December 1999. The Decision does allow for programmatic review and revision of the EMP subject to approval by the SWRCB - it in fact requires triennial program reviews-, but the legal underpinnings and basic program requirements are beyond the scope of this review.

Although program resources are finite and fixed, we believe that they are adequate for implementation of the redesigned monitoring program as envisioned by review participants, especially if additional funds for one-time equipment purchases can be secured from IEP, CALFED or other sources. We remain, however, concerned about long-term support (funding, staff time, etc.) for vital EMP special studies. We believe that along with the actual monitoring activities, a successful monitoring program requires an integrated special studies element to ensure that monitoring

[1] More detailed information about the EMP and the programmatic review is available at http://iep.water.ca.gov/emp (for password protected pages: user name: emp; password: sancarlos).

design, procedures, and products adequately reflect current management needs, monitoring techniques, and knowledge about the system of interest. In the "Review and Recommendations" report[2], we have listed and prioritized a series of special studies recommended by program reviewers. These studies address major uncertainties about system variability, system processes, and monitoring techniques. These uncertainties need to be resolved to most effectively improve the monitoring design. As currently envisioned, funding for these studies would largely come through participation of EMP staff in competitive proposal processes (IEP, CALFED), *i.e.* there is no guaranteed funding. We believe, however, that only guaranteed funding for special studies and its administration by the scientists carrying out these studies can ensure a substantially improved monitoring design for all EMP elements by the beginning of the next IEP review cycle (2007).

The review core team thus urges the IEP Management Team and Coordinators to consider prioritizing monitoring-related special studies recommended in formal IEP monitoring program reviews such as the 2001-2002 EMP review during the annual IEP study selection process, provided these studies fulfill all standard IEP study criteria. We believe that ideally, the IEP Management Team and Coordinators should set aside some funding for special studies identified in comprehensive monitoring program reviews. This would ensure implementation of review recommendations, and also provide an incentive for high-quality program reviews. In the absence of guaranteed funding, we will do our best to fund EMP special studies through budget reallocations within the EMP, collaborations, and proposal submissions to competitive funding processes. We are, however, unable to guarantee that all review recommendations will be adequately addressed unless we can count on funding for special studies.

Among the recommended special studies, studies addressing EMP benthos monitoring represent a special case. All SAG review participants agreed on the need for fundamental and comprehensive consideration of the benthos monitoring element through intense special studies and study design examination. In response to review findings about EMP benthos monitoring and discussions at the first BEET meeting on October 3, 2002, EMP staff and collaborators have submitted three proposals for studies designed to address benthos data and information needs to the IEP. While these proposals received favorable peer reviews and were recommended for IEP funding, current IEP budget shortfalls prevent funding of any new studies. The three EMP proposals will thus be submitted for CALFED funding, and delays are expected for these studies.

To provide appropriate data for the spatial redesign of the EMP benthos monitoring element, we propose to conduct more spatially intense sampling in 2003-2004, while at the same time reducing routine benthos monitoring at the current ten benthos sites from monthly to quarterly (every three months). The temporary reduction in sampling frequency would free up EMP resources to conduct the more spatially intense sampling without requiring additional (competitive) IEP funding.

[2] Available at http://iep/emp/EMP_Review_Final.html

Based on preliminary analyses of EMP benthos (*Corbicula*) data by Alan Jassby mentioned in the SAG report (page 30) and the relative inconsistency of EMP benthos sampling in the past, we feel that replacing more frequent with more spatially intense sampling for the duration of the study period does not pose an overly harmful threat to the long-term consistency of the benthos monitoring program element. The first spatially intense sampling event took place in May 3003. EMP staff participated in CALFED-funded benthic sampling by Jan Thompson, USGS at over 160 Delta sites. The EMP objective behind this and, if resources allow, additional spatially intense surveys is to investigate spatial variability of benthic community composition and abundance in the Delta at high spatial resolution. Results are expected to provide a basis for benthos monitoring redesign. More frequent routine sampling would resume after the two-year study period, and a proposal for a redesigned EMP benthos element based on study findings would be submitted to the SWRCB as part of the next triennial review report due in December 2005 for implementation in 2006. If needed, EMP staff would continue to apply for additional funding for benthos studies through the competitive proposal processes of IEP and CALFED. The benthos studies and the ensuing EMP-benthos redesign would be conducted by EMP staff and outside collaborators under the oversight of the newly formed IEP Benthos Estuarine Ecology Team (BEET), IEP "Forum" participants, and in consultation with the IEP SAG, where appropriate. For more about benthos monitoring, see the section entitled *"EMP response regarding benthos and phytoplankton monitoring,"* below.

General SAG recommendations

While emphasizing the overall success and value of the EMP, the IEP SAG review also contained substantial, constructive criticism including numerous recommendations for general and detailed program improvements. We address in detail the more specific issues raised by the SAG in the attached Tables. These Tables also provide short summaries of our responses to the more general recommendations discussed below. The following sections provide detailed responses to the SAG's major criticisms and recommendations.

EMP response regarding data, products, and intellectual investment

We wholeheartedly concur with the SAG's recommendation that the EMP should focus more on turning data into useful information products by increasing human intellectual investment. Four scientists with Ph.D.s have been hired by DWR and USBR in 2000 – 2002 to bolster the program's human intellectual resources (Marc Vayssieres, Phil Giovannini, and Anke Mueller-Solger, DWR, and Erwin VanNieuwenhuyse, USBR). EMP staff have also begun to investigate and create more contemporary and useful reporting, data management, and quality assurance

tools such as web-based, geo-referenced[3] information reporting tools, improved meta-data linked to the web-based data base, etc. We plan to analyze and synthesize results in accordance with program objectives and questions (see below). In general, we hope to foster an environment where all program staff is encouraged to participate in both monitoring and EMP-related special studies in all subject areas, including reporting in newsletters, journals, etc. This is not always an easy thing to do given the realities of public agencies, and patience is required. Recently progress has been made in this regard, however, as evidenced by current or planned special studies by EMP staff (see examples below and in *EMP response regarding sampling design and program integration)* and the productive IEP Water Quality Project Work Team meetings, see http://iep.water.ca.gov/emp/WQPWT/IEP%20WQ%20PWT%20meetings.html (user name: emp; password: sancarlos).

Examples of ongoing or planned special studies by EMP staff include:

1. Test of new DO probe technology *(Van Nieuwenhuyse & Dempsey, ongoing, IEP 2003 special studies funding)*
2. Three related benthos studies *(Messer et al., Gehrts et al., and Peterson et al., proposals submitted to IEP and recommended for 2004 funding, see http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html. However, due to budget shortfalls, studies cannot be funded at this time and proposals will be submitted to CALFED)*
3. Evaluation of phytoplankton enumeration procedures *(Mueller-Solger, Cloern, & Dufford, in progress, EMP funding)*
4. Comparison of chlorophyll *a* laboratory analysis procedures (*Triboli & Mueller-Solger, near completion, EMP funding*).
5. Lateral water quality variability at Benicia-Martinez (*Burau, Hymanson, Van Nieuwenhuyse, and Kalff, USGS-DWR-USBR collaborative study planned for 2003-2004, EMP and special USBR funding*)
6. Historical cross-channel benthos variability (*Vassieres and Peterson, in progress, EMP funding, poster presentation at IEP-Asilomar 2003*)
7. Central Delta "benthic boogie" *(Jan Thompson, Mueller-Solger, Vayssieres et al., spring 2003, CALFED & EMP funding)*
8. Evaluation of horizontal chlorophyll *a* fluorometric profiling procedures and data records (*Vayssieres et al., in progress, EMP funding*)
9. Evaluation of the utility of remote sensing in the upper San Francisco Estuary (*Vayssieres and Mueller-Solger, proposal submitted to IEP for 2004 funding with EMP and IEP special studies funding, see http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html. Recommended for funding, but availability of funds currently unclear.*)
10. Phytoplankton studies (*Lehman et al., EMP funding*)

[3] As a basis for this type of reporting we have recently worked to identify geographic coordinates for EMP and other water quality monitoring stations in the estuary and organize them in a GIS database. Current results of this work include a proposed new D-1641 "Table 6" with geographic coordinates for all stations in D-1641 Table 5, a proposed revised D-1541 "Figure 4, " and a poster presentation by M. Vayssieres and S. Hararder at the CALFED Science Conference 2003.

Please note that these are just examples of a few relatively small studies that have recently been proposed or are in progress. They demonstrate the shift in intellectual approach, but do not necessarily reflect study priorities identified during the EMP review, although some of these studies were stimulated by the ongoing review discussions. Prioritized study plans for 2003-2007 resulting from the review are given in the "Special Studies" table of the review synthesis report and some important studies are also discussed in the following sections.

EMP response regarding program aims

According to the SAG review, the EMP would greatly benefit from more specific "aims" for the four program elements and the whole program. These aims should follow the original EMP mission, guide its design, and focus its products. In response to this recommendation, we propose a hierarchy of program goals, objectives, and specific questions of increasing specificity.

a) The current and original overall **goal** of the EMP is given in water right decision D-1641: "ensure compliance with water quality standards (called objectives) and identify water quality and ecological changes potentially related to water project operations." To accomplish this, it is necessary to capture changes in environmental variables related to a variety of likely natural and anthropogenic influences and separate the longer-term trends of interest (>weeks) from the shorter-term "noise" (tidal signals, etc.), and the impact of project operations from all other influences. This is a broad goal, and thus calls for the most comprehensive program design and data analyses feasible within the existing resources. At the same time, it allows for maximum flexibility regarding reporting of results and neither greatly guides nor very narrowly constrains monitoring and accompanying special studies. An even broader goal is prescribed for the EMP and other IEP program by the IEP mission to "provide information on the factors that affect ecological resources in the Sacramento - San Joaquin Estuary that allows for more efficient management of the estuary."

b) Consistent with the above goal, we formulated the following list of more specific **objectives** for EMP monitoring of water quality, phytoplankton, zooplankton, and benthos in the upper San Francisco estuary. We provide short discussions of each of these objectives below this list. EMP sampling design follows these objectives and is described in more detail in the *sampling design and program integration* section.

    1. On an ongoing, long-term basis, collect and analyze environmental data to characterize spatial and temporal variability of ambient concentrations and

fluxes of physicochemical and biological constituents at appropriate spatial (local, regional and system-wide) and temporal (high-frequency "noise" versus longer-term "signal") scales. Particular attention should be given to constituents for which water quality objectives exist.

2. On an ongoing, long-term basis, characterize spatial and temporal variability of physicochemical and biological constituents in a variety of important "habitat types" over time.
3. Detect and monitor the establishment, distribution, and temporal trends of non-native phytoplankton, zooplankton, and benthic invertebrate populations.
4. Through synthesis of EMP and other data sets, develop hypotheses about ecological processes and underlying mechanisms (including water project operations) for further consideration in special studies.
5. Provide appropriate data for modeling (model boundary conditions), especially for compliance constituents (e.g., temperature and electrical conductivity) at compliance sites.
6. Maintain and continue adding to the EMP's valuable long-term data record, especially at the most long-term stations, and ensure long-term data compatibility.
7. In a timely manner, provide EMP data and associated meta-data in a relational, web-accessible database. Provide results of routine analyses in a similar way.

Objective 1 is aimed at collecting appropriate baseline and compliance data and information for fulfilling the D-1641 mandated program goals. To address objective 1, we propose a revised EMP sampling design that would provide suitable data to determine how physicochemical and biological constituents are spatially distributed, and how their distribution changes through time at various spatial (local, regional, system-wide) and temporal scales (primarily: time scales >weeks). At the core of the proposed spatial design (Fig. 1 and Fig. 9, Tables 1 and 2) are "ambient stations" and "flux stations" (Fig. 7). Monitoring at ambient stations is intended to capture prevailing conditions in specific regions. Regions are delineated based on geometry, regional scale hydrodynamic transport processes, and hydrologic influences, as well as ecological (habitat) characteristics (Fig.s 2 – 6, Table 4). Flux stations are associated with tidal flow stations (operated with or by the USGS) and used to calculate water, salt, sediment, nutrient, chlorophyll and other fluxes (loads) at key locations along major flow paths in the upper estuary. Ultimately, all stations should be located within one tidal excursion range of each other (Fig. 8) to facilitate estimation of spatial structure based on knowledge of tidal transport of water parcels. For further design details and underlying concepts, see *EMP response regarding sampling design and program integration*, below.

Furthermore, we propose that EMP staff and/or outside experts develop strategies for the most useful and effective routine data analyses to detect

ecologically meaningful patterns and longer-term trends in the long-term EMP data record. While first conducted as special studies, the most successful analysis techniques should be incorporated into routine EMP data analyses procedures as soon as possible to satisfy objective 1. For example, we may use long-term data for statistical analyses of spatial and temporal variability to determine regions with similar constituent magnitudes (clustering techniques) or dynamics (PCA techniques). Boundaries between regions may be further explored using high-resolution maps of spatially continuous data (e.g. from horizontal profiles or remote sensing) and statistical techniques such as tree based modeling. We may then compute magnitude averages and temporal trends for individual constituents within regions, and system-wide. Where flow data has been measured at regional boundaries (i.e., at the "flux stations"), exchanges between regions and regional and system-wide mass and constituent balances can be computed for periods of differing lengths. More comprehensive analyses using long-term data records for multiple constituents may help formulate hypotheses about mechanisms responsible for the observed trends, see objective 4. Analyses should be updated at appropriate intervals, and short-term observations should be compared to the detected longer-term trends. Overall, this objective would contribute to detecting "ecological changes," and if and how these changes are "related to project operations," as required by D-1641.

Objective 2 and the following objectives are intended to yield more informative monitoring products and address current information needs identified during the EMP review, thus fulfilling the IEP goal to "provide information on the factors that affect ecological resources in the Sacramento - San Joaquin Estuary that allows for more efficient management of the estuary." Different habitat types support different species and ecological processes, and several habitat types in the San Francisco estuary are thought to be of critical importance for the preservation and propagation of native species, including several endangered species. To satisfy objective 2, we thus propose to monitor and better define eight habitat types in the San Francisco estuary distinguished based on ecologically important physical and chemical features. These habitat types include shallow subtidal wetlands and flood plain habitat, two important habitat types currently not monitored by the EMP. The eight targeted habitat types are represented by the EMP stations shown in Fig. 6 and Table 4. The habitat types are 1) Floodplain Drainage Channel, 2) Flooded Island (shallow tidal lake), 3) Tidal River Channel, 4) Tidal Marsh Slough, 5) Estuarine Channel, 6) Estuarine Embayment, 7) Bay Channel, 8) Bay shoal. One of the goals of the proposed spatial EMP design revision is to better represent each identified habitat type and to reduce the current overrepresentation of Tidal River Channel habitat. Habitat types 7 and 8 (located mostly in the western estuary) would only be targeted for zooplankton monitoring because other programs monitor all other EMP variables in the western estuary. During the management review phase, objections were raised against a westward expansion of the mandated EMP

monitoring because of weak or non-existent impacts of water project operations in the San Francisco Bay, especially South Bay. There was considerably less resistance to incorporating this monitoring element into the non-mandated IEP-DFG "Bay Study." We thus continue to recommend zooplankton monitoring in the Bay, albeit as an IEP Bay Study rather than an EMP element.

The San Francisco Estuary is a highly invaded estuary (Cohen and Carlton 1995, 1998). Invading species have the potential to substantially affect water quality and native species assemblages. These effects may alter or mask the effects of water project operations and contribute to the observed status and trends of water quality and biological constituents monitored by the EMP. **Objective 3** seeks to assess the distribution and temporal trends of non-native species already present in the system and detect future invasions.

Monitoring and analyses conducted to satisfy objectives 1 - 3 should yield observations that could lead to the formulation of hypotheses about ecological processes and underlying mechanisms (**objective 4**) and possibly evaluations of "ecosystem health." These hypotheses should be addressed by EMP staff and/or external scientists in separately funded special studies. Ultimately, EMP data and analyses should thus contribute to a better understanding of the causal relationships between environmental factors (including project operations and climate fluctuations) and hydrodynamic and ecological patterns and processes in the upper estuary.

EMP data is also useful for numerical modeling applications such as water project operations forecasting and planning studies that are principally aimed at predicting changes in salt field dynamics due to large civil engineering projects or habitat restoration projects. To provide appropriate data for modeling (**objective 5)**, we propose to continuously monitor EC and temperature and in some cases additional variables (e.g. chlorophyll *a* fluorescence and turbidity) at "flux" stations or natural boundaries between regions with priority given to designated D-1641 compliance monitoring stations (Fig. 7).

Finally, it is evident that a long-term environmental data record such as the EMP data set has great intrinsic value for basic and applied scientific explorations and becomes increasingly more valuable with continued monitoring as long as program consistency is maintained. **Objectives 6 and 7** seek to ensure data continuity and improve accessibility and usefulness. To this end, EMP staff is currently investigating which stations have the longest intact and uninterrupted data records. We propose to designate these stations as "long-term stations" that shall receive high priority to be maintained with comparable monitoring procedures in the future. Procedural changes shall be implemented by the EMP only after results produced simultaneously with the historical method and the potential new method have been thoroughly

evaluated to ensure method comparability. EMP staff is also in the process of investigating, documenting, and implementing new data base protocols and restoring compromised or currently unavailable historical data and meta-data records. Improved data-to-information approaches are also currently under investigations, as explained for objective 1, above.

c) Specific **questions** that should be answered through EMP monitoring and special studies on an ongoing basis relate back to the program goals and objectives and address specific areas important for D-1641 compliance or to resolve critical uncertainties related to ecosystem management decisions and scientific understanding. Some questions are fairly basic and the intent is to provide answers with automated, web-based reporting tools, while others require more complex analyses and would yield reports and peer-reviewed publications. The questions also identify how we can integrate data among monitoring programs to further our understanding of conditions within the estuary. The sampling design determined by the program objectives, above, and described in more detail in the next section (*EMP response regarding sampling design and program integration*), would control the data stream available to answer each question (*e.g.*, discrete or continuous, replicates among regions, etc.). The answers to these questions would be provided in specific program products released in a timely manner using traditional (*e.g.*, reports, newsletter contributions, journal publications of staff analyses) as well as more innovative reporting tools (*e.g.*, interactive web sites with data base access and custom web tools). Not all possible questions are listed here, and we expect the questions to change with changing management priorities and new physical and ecological insights. Therefore, we will need to continuously solicit and consider new questions from managers and scientists.

1. How does EC vary in space and time at different scales? What does this tell us about salinity intrusion (e.g., what was the maximum salinity intrusion for a given year, relative to the water year, and what was the intrusion during certain key times (e.g., before the VAMP, after the VAMP, etc.)? Were the standards in D-1641 met? (Web-based reporting tools and staff analysis summarized in annual report).
2. What is the spatial variability of individual constituents during specific (short-term) periods of interest? Using high resolution monitoring (i.e., measured continuously and in some cases via remote sensing) and hydrodynamic modeling, what is the spatial variability of essential constituents such as EC, water temperature, dissolved oxygen, turbidity, and chlorophyll a at high spatial resolution, and how does it change over time? (Web-based reporting tools (maps) and summary in annual report).
3. What is the long-term trend in individual constituents at individual stations? How do data collected over the last year compare to the long-term trend? (Web-based reporting tools and summary in annual report).
4. What are the long-term regional averages in various constituents, and exchanges between regions? How do data collected over the last year

compare to the long-term regional averages? (Web-based reporting tools and staff analysis summarized in annual report). Examples of important management uncertainties targeted by this question and ecologically relevant follow-up questions include the next five questions (questions 5. - 10.).

5. What is the long-term trend in X2? How do data collected over the last year compare to the long-term trend? Is there a relationship between X2 and the abundance and survival of living resources?
6. What is the long-term trend in water temperature? How do data collected over the last year compare to the long-term trend? Is there a relationship between water temperature patterns in various regions and the abundance or distribution of resident fishes?
7. What is the long-term trend in dissolved oxygen concentrations in the Stockton Deepwater Ship Channel? How do data collected over the last year compare to the long-term trend? Were the standards in D-1641 met?
8. What is the long-term trend in regional water clarity? How do data collected over the last year compare to the long-term trend?
9. What are the long-term trends in various constituents among habitat types? How do data collected over the last year compare to the long-term trend?
10. What are the patterns in fluxes of salt, turbidity, and chlorophyll at the major input and exit points in the Delta? (Web-based reporting tools and staff analysis summarized in annual report; requires collocation of EMP continuous monitoring stations with flow measurement stations ("flux stations")).
11. Are seasonal, climatic (e.g., drought and flood) or other signals evident in the EMP data collected over the last year? How does this compare to previous years and long-term trends? (Staff analysis completed and reported each year).
12. What relationships exist between regional water quality, hydrological, and meteorological patterns and the abundance or distribution of phytoplankton, zooplankton or benthos? Do they point to specific causal mechanisms? (Staff analysis completed and reported at reasonable intervals (every 1 - 5 years)).
13. How can EMP procedures (field, laboratory, data handling and analysis, reporting, etc.) be optimized to best fulfill program goals and objectives? (Ongoing EMP staff efforts and regular internal and external program reviews; findings and decisions reported on EMP web site, in presentations to IEP management and project work teams, agency managers, water project contractors, SWRCB, etc.)

EMP response regarding sampling design and program integration

a) Temporal Design

Consistent long-term, low-intensity monitoring by the EMP has shown significant long-term trends in a number of monitored variables over several decades. For example, through statistical analyses of EMP data, Jassby et al. (2002) showed

significant declines in Delta-wide phytoplankton biomass and productivity over the past three decades which may be linked to similar declines observed in zooplankton and native fishes. They were also able to identify mechanisms responsible for the observed trends, including anthropogenic impacts such as damming of rivers. More short-term, high-intensity sampling by other programs and studies have shown impressive short-term variability in important constituents such as suspended solids, dissolved oxygen, and phytoplankton biomass due to hydrodynamic transport and local processes (Burau et al., 2000, Lucas et al., 2002). It is likely that in the dynamic San Francisco estuary, daily or spring-neap variations in water quality are often on the order of, or greater than, longer-term (e.g., seasonal or annual) variations. This daily "noise" may thus mask important longer-term "signals" that are not as pronounced as the remarkably strong phytoplankton declines.

The EMP aims discussed above are primarily directed at capturing longer-term trends (seasonal, annual, or longer) resulting from natural and anthropogenic influences. To better separate long-term trends (signals) from high frequency variations (noise), the EMP needs to be better able to recognize and characterize high frequency variations. We thus propose to establish more continuous monitoring stations, more directly link continuous and discrete monitoring, and more closely collaborate with other programs operating such continuous monitoring stations. Specifically, we propose to start by establishing a cohesive network of continuous monitoring stations for electrical conductivity (EC) and water temperature, two key water quality constituents in the estuary for which robust sensor technology is available. Ultimately, we propose to work towards a station design that has continuous stations located within a tidal excursion of neighboring stations throughout the upper estuary to enable data analysis at the dominant transport (tidal) time scales (Tables 1 and 2, Fig.s 1 and 8). Such a continuous monitoring station network would also enable higher-resolution assessments of spatial variability, see b), below. For efficient implementation, discrete EMP stations would be analytically integrated and/or consolidated with existing neighboring continuous stations after establishing data comparability (Tables 4 and 5). In addition to EC and water temperature sensors, some EMP stations would also include continuous monitoring sensors for other important variables such as turbidity, pH, dissolved oxygen, and chlorophyll *a*. These stations would include the historical EMP "multi-parameter" stations and key habitat representatives (Tables 4 and 5).

Discrete sampling for the remaining EMP water quality variables would largely be carried out during routine maintenance of the continuous monitoring stations at alternating spring and neap tides to avoid tidal aliasing. Due to the need for a winch and nets, zooplankton and benthos monitoring would continue to be largely vessel-based and also be carried out at alternating spring and neap tides. The acquisition of a new research vessel by the USBR and its retrofitting with two davits will enable simultaneous zooplankton and benthos sampling which will further improve monitoring efficiency.

b) Spatial Design

We propose a stratified fixed-station sampling design with the strata based on physical and ecological conceptual models of the estuary. The fixed station-design would be retained to preserve long-term monitoring continuity. In addition, the proposed station network (Fig. 1) would be matched to the greatest possible degree with historical EMP stations, especially for those with consistent data streams spanning three or more decades ("long-term stations"). For greater monitoring efficiency, we propose to combine several discrete and continuos stations located in close proximity of each other at the existing continuous station sites (Tables 4 and 5) provided there is good agreement between data recorded at these neighboring stations (see also the Water Quality Subject Area Team Report 2001). For some stations we suspect or know about spatial variability issues that likely affect the representativeness of the station (e.g. station D6A (Martinez)). We propose to conduct special studies to document cases of lateral variability in the existing network, and, if necessary and possible, sampling stations would be moved to ensure the data obtained are most representative of local conditions (e.g. D6A might eventually be moved to center channel location, "D6B", Table 5. See also *Special studies related to program design and integration*, below and Tables 6 and 7). These studies would first target stations where spatial variability problems are already suspected based on previous sampling, local geometry, or other information.

Physically, we separate the Bays and Delta into strata based on geometry, on the influence of regional scale hydrodynamic transport processes, and on hydrologic influences (which in this context include river inputs, pumping, gate operations and barrier manipulations). In San Pablo and Suisun Bays, stations are located at important bathymetric features: "sills" and deeper areas associated with gravitational circulation "cells" (Table 4 and Fig.s 2 and 4). In the Delta, the physically determined strata (Table 4 and Fig.s 3 and 4) are quite similar to regions determined statistically from the long-term EMP data set (Table 4 and Fig. 5; Lehman and Smith 1991, Lehman 1996, CDWR 1996, Jassby and Cloern 2000, Jassby 2002). Ecologically, we distinguish eight habitat types, including two in the lower estuary (Table 4, Fig. 6). These habitat types are distinguished based on ecologically important physical and chemical features such as depth, turbidity, tidal energy, residence time, connectivity to surrounding water bodies, wet period, etc.

Based on the monitoring objectives and questions listed above, the EMP should determine temporal variability within the physical and ecological regions represented by the stations shown in Figures 3, 4, 5, and 6, and the exchanges between them and across the entire upper estuary. Accordingly, sampling stations are divided into two distinct categories depending on whether a sampling station's primary aim is to estimate mass flux across regions (a flux station) or temporal variations within a region (an ambient station) (Fig. 7). Flux stations are located along the major water movement routes across the upper estuary, i.e. from the Sacramento River and San Joaquin Rivers to the water export facilities and out into the Bay. At flux stations, flow (not traditionally measured by the EMP) should be measured concurrently with EMP constituents by or in collaboration with the USGS. The remaining proposed

stations are ambient stations. These stations would be distributed throughout the upper estuary (and in the lower estuary for IEP zooplankton monitoring) to represent environmental conditions in the identified regions and habitat types. As mentioned above, all continuous EMP stations should ultimately be located within one tidal excursion of each other to estimate spatial structure of variables at various temporal scales based on knowledge of tidal transport of water parcels (Fig. 8).

In addition to measurements at fixed stations, vessel-based, fixed depth flow-through measurements of EC, turbidity, dissolved oxygen, and chlorophyll *a* fluorescence between fixed stations would provide high spatial resolution for these variables during the zooplankton-benthos monitoring cruises. Eventually (after exploring its utility and applicability in the Delta through special studies, see appendix), we may also propose routine remote sensing for high spatial resolution monitoring of some constituents. Together with fixed-station continuous measurements, this would provide the ability to better estimate spatial structure without abandoning the historical long-term fixed-station design and thus orphaning the valuable long-term data set in favor of probabilistic sampling approaches (e.g., random and/or rotating designs). For more information about all individual proposed EMP stations, see Tables 1 - 5.

c) Program integration

The denser network of strategically located continuous monitoring stations described above would allow more comprehensive analyses at appropriate (including tidal) time scales and spatial scales. For constituents monitored at fixed stations, we would attempt to deduce their day-to-day spatial structure based on knowledge of tidal excursion ranges and local processes. This knowledge would enable spatially intense data analysis of multiple EMP variables and better assessments of anthropogenic impacts such as project operations as well as natural phenomena such as climate change. It would also allow for more statistical analyses of regional and system-wide long-term trends as described in objective 1, above, although in some cases these analyses may require additional stations. Remote sensing and the vessel-based, fixed depth flow-through measurements between fixed stations may serve to test the accuracy of spatial extrapolations of fixed station data.

Overall, the proposed design attempts to increase consistency among program elements by increasing the number of variables monitored concomitantly at each proposed EMP station. This would facilitate more comprehensive syntheses and analyses of results from all program elements. Redundancies with other programs will be further investigated and, wherever possible, eliminated.

d) Special studies related to program design and integration

We agree with the SAG that in many cases, more studies are needed to investigate local and regional constituent variability, the responsible processes, and the resulting ability to extrapolate between stations and sampling events or to compute regional averages, etc. Such studies may follow the approaches described in Jassby et al. 1997, Burau et al. 2000, Jassby et al. 2002, and Lucas et al. 2002. Various studies have been

identified and prioritized in the program review (Table 6), and several have already been set in motion by IEP staff or independent scientists. These include the individual studies listed above in *EMP response regarding data, products, and intellectual investment* and

1. Zooplankton monitoring expansion and methods *(Kimmerer & Orsi, IEP, in progress)*
2. Primary production monitoring design, data analysis, & forecasting *(Jassby (with Mueller-Solger), ongoing CALFED ERP-02-207 grant)*
3. Historical benthos biomass at long-term IEP EMP benthos monitoring stations. *(K. Gehrts and A. Mueller-Solger, proposal submitted to IEP, see http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html)*[4]
4. Benthos Bio Guide (*Messer, C., Mueller-Solger, A., and M. Vayssières, proposal submitted to IEP, see http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html)*[4]
5. Retrospective analysis of long-term benthic community data. (*Peterson, H. A., Vayssières, M., and J. Thompson proposal submitted to IEP, see http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html)*[4]

Other ongoing studies of hydrodynamic transport processes and spatial and temporal variability of various constituents will also be helpful in improving EMP integration and analyses (e.g., the ongoing CALFED ERP study headed by J. Cloern, hydrodynamic transport studies by J. Burau and others at the USGS, etc.).

EMP response regarding benthos and phytoplankton monitoring

In completing this programmatic review, we have come to recognize that the benthos and phytoplankton program elements need fundamental rethinking and careful consideration. According to the SAG, the phytoplankton monitoring element is faced with procedural issues and a lack of clear aims as well as poor data availability, while the current benthos monitoring element may likely suffer from a severely deficient sampling design. These issues urgently need to be addressed through extensive special studies and solicited outside expert advice. The procedural and data base issues identified for the phytoplankton element are already being addressed and should be resolved soon. The aims for this program element should follow the overall program goals and objectives identified above. They will be further explored in the funded CALFED study by A. Jassby and EMP staff as well as in IEP Estuarine Ecology Team (EET) meetings. We expect to develop detailed recommendations for phytoplankton monitoring for implementation during the next review cycle.

The current benthos monitoring design includes monthly, replicated benthos sampling at ten fixed stations. In contrast to plankton, benthos assemblages in

[4] Proposals for studies 3, 4, and 5 will be resubmitted to CALFED due to IEP funding shortages.

estuaries often exhibit substantial variability at small spatial scales, but less variability at short temporal scales. Many EMP reviewers voiced concerns that the current program design does not adequately take spatial variability into account, and specifically that it might not have adequate spatial resolution to observe relevant spatial patterns and trends, while possibly overcollecting temporal data. Benthos has never been sampled in the upper estuary with substantially higher spatial resolution than that of the current EMP sampling scheme. It is thus not possible to resolve this issue based on analyses of existing data, and special studies designed to collect and analyze adequate spatial data are urgently needed. Because these studies are so urgently needed, we feel that we cannot rely on non-EMP funding acquired through competitive proposal processes, but rather should reallocate existing EMP monitoring funding to these special studies. As mentioned in *EMP response regarding constraints*, above, we thus propose to monitor benthos seasonally (i.e. quarterly - every three months) instead of monthly and redirect the liberated resources to special studies specifically designed to address the issues surrounding the spatial and temporal design of benthos monitoring in the upper estuary. After these studies are completed, we propose to redirect resources back to more extensive benthos monitoring using an improved monitoring design based on study results. These benthos studies would be conducted by EMP staff and outside collaborators under the oversight of the newly formed IEP Benthos Estuarine Ecology Team (BEET). The BEET will also be used as a forum to formulate objectives for benthos monitoring that reflect contemporary customer needs and will help guide the redesign of EMP benthos monitoring.

First BEET efforts have led to several proposals for additional funding for retrospective analyses of existing data and to acquire and organize important additional data and information (see studies 3.-5. listed *in EMP response regarding sampling design and program integration, d)*, above, and *http://iep.water.ca.gov/emp/WQPWT/WQ_PWT-IEP_Special_Studies.html*). These proposals have been submitted to the IEP Management Team for consideration and recommended for 2004 funding. Due to IEP budget deficits, however, these studies cannot receive 2004 funding and will thus be resubmitted to CALFED. A fourth study, dubbed “benthos boogie,” is conducted in collaboration with Jan Thompson, USGS. This study is supported by CALFED through Jan Thompson’s existing grant and by the IEP EMP with resources liberated by implementing seasonal instead of monthly sampling starting in January 2003. The goal of this joint study is to obtain clam grazing rates throughout the upper estuary (CALFED objective) and to acquire a “snapshot” data set of benthos community compositions, abundance and distribution at high spatial resolution to begin to unravel the questions surrounding the spatial design of benthos monitoring (IEP EMP objective). This study focuses on the upper estuary from the Sacramento River just upstream of the mouth of the Yolo Bypass to the north to Channel Point to the south and Carquinez Straight to the west. Sampling was carried out in May 2003 according to a stratified sampling design based on habitat type, physical characteristics such as geometry and hydrology, and anthropogenic impacts. Samples from more than 150 sites were collected benthic community and sediment analysis as well as for several other important variables

such as water temperature, dissolved oxygen, salinity, chlorophyll, particulate organic carbon, and inorganic nutrients. For processing (enumeration and weighing), benthos samples are divided into two size fractions. The larger size fraction is processed by the USGS, while the EMP will process the smaller size fraction. The combined results will be analyzed for spatial heterogeneity patterns that may lead to more regionally focussed studies and ultimately to recommendations for an improved benthos sampling design.

In summary, we propose the following course of action to resolve phytoplankton and benthos monitoring design issues: 1) Over the next three years, continue to sample phytoplankton at all water quality sampling stations. During a two-year study period, monitor benthos quarterly at the ten stations listed in Table 1; resume monthly sampling thereafter. 2) With the newly formed IEP Benthos Estuarine Ecology Team (BEET) and the IEP EET, develop recommendations for specific program questions/objectives based on reviews of other phytoplankton and benthos monitoring programs and consultations with managers, scientists, stakeholders, IEP project work teams, and other data and information customers. Review methods used and consider alternative methods if current methods seem inappropriate. 3) Conduct targeted special studies (e.g., the "Benthos Boogie" and "Retrospective Analysis," above) and consider results of new and ongoing CALFED work (Alan Jassby, Jan Thompson, Jim Cloern and others) to better understand spatial variability on a local and regional scale. This should help to determine allocation of sample effort and associated trade-offs. The newly formed IEP BEET should guide benthos investigations. Also conduct method comparison studies, if needed. 4) Collaborate with outside experts on more comprehensive analyses of existing data and conduct additional special studies to increase available information and aid in the development of recommendations for redesign of the program; and 5) develop specific recommendations for program questions/objectives and a revised monitoring design, and present them to IEP management and the SWRCB for review/approval during the next review cycle. Again, we expect the IEP BEET to play an important role in formulating these recommendations for benthos monitoring.

Additional comments by individual SAG members

Individual IEP SAG members reviewed elements of the EMP and provided particularly helpful element-specific comments and recommendations, which we respond to in Table C, below.

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Table 1: Proposed modifications to EMP monitoring in D-1641, Table 5 (p. 192) with highlighted changes. Also indicated: Operators for D-1641 stations not operated by the IEP EMP.

Station ID[1]	Station Type[2]	Station Description[3]	Cont.Rec.[4]	Cont. Multi-para-meter[5]	Discrete Physical/ Chemical[6]	Discr. Phyto-plank-ton[7]	Discr. Zoo-plank-ton[8]	Dis-crete Ben-thos[9]
C2	C	Sacramento River @ Collinsville	USBR-CVO					
C3	B	Sacarmento River @ Greens Landing	USBR-CVO		(-)	(-)		
C3A	B	Sacramento River @ Hood		*	**X**	**X**	**X**	
C4	C	San Joaquin River @ San Andreas Landing	USBR-CVO					
C5	C	Contra Costa Canal @ Pumping Plant #1	USBR-CVO					
C6	C	San Joaquin River @ Brandt Bridge site	DWR-CD					
C7A	B	San Joaquin River @ Mossdale Bridge (near C7)		*				
C8	C	Old River near Middle River	USBR-CVO					
C9	**C&B**	Clifton Court Forebay Radial Gates		DWR-O&M	**X**	DWR-O&M	**X**	
C9-R	**B**	West Canal @ Mouth of CC Forebay Intake						*
C10	**C**	San Joaquin River near Vernalis	USBR-CVO		(-)	(-)		
C10A	**B**	**San Joaquin River near Vernalis @ San Joaquin River Club**		**X**	**X**	**X**	**X**	
C13	C	Mokelumne River @ Terminous	USBR-CVO					
C14	C	Sacramento River @ Port Chicago	USBR-CVO					
C19	C	Cache Slough @ City of Vallejo Intake	USBR-CVO					
D4	B	Sacramento River above Point Sacramento			*	*	*	*
D6	B	Suisun Bay @ Bull's Head Pt. near Martinez			*	*	*	*
D6A	B	Suisun Bay @ Martinez		*				
D7	B	Grizzly Bay @ Dolphin near Suisun Slough	**X**		*	*	*	*
D8	B	Suisun Bay off Middle Point near Nichols			*	*	*	
D9	**B**	**Honker Bay near Wheeler Point**	**X**		**X**	**X**		
D10	**B**	Sacramento River @ Chipps Island					*	
D10A	**C&B**	Sacramento River @ Mallard Island		*	**X**			
D11	**B**	**Sherman Lake near Antioch**	**X**		**X**	**X**		
D12	**B**	San Joaquin River @ Antioch Ship Channel					*	
D12A	**C&B**	San Joaquin River @ Antioch Water Works		*	**X**			
D15	C	San Joaquin River @ Jersey Point	USBR-CVO					
D16	B	San Joaquin River @ Twitchell Island					*	*
D19	**B**	**Franks Tract near Russo's Landing**	**X**		**X**	**X**	**X**	
D22A	**C&B**	Sacramento River @ Emmaton	USBR-CVO & DWR-CD					
D22	**B**	Sacramento River @ Emmaton (near D22)					*	
D24A	**C&B**	Sacramento River below Rio Vista Bridge		*	**X**			
D24-L	**B**	Sacramento River below Rio Vista Bridge, left bank						*
D26	B	San Joaquin River @ Potato Point			*	*	*	
D28A	B	Old River opposite Rancho Del Rio			DWR-CD	*	*	*
D28B	B	Old River at Bacon Island	DWR-CD					
D29	C&B	San Joaquin River @ Prisoners Point	*		**X**	**X**	**X**	
D41	B	San Pablo Bay near Pinole point			*	*	**X**	*
D41A	B	San Pablo Bay near the Mouth of the Petaluma River			**X**	**X**	**X**	*
DMC1	C&B	Delta-Mendota Canal @ Tracy Pump. Plt.		USBR-CVO				
P8	B	San Joaquin River @ Buckley Cove			*	*	*	*
P8A	B	**San Joaquin River @ Rough and Ready Island**		*				
P12	C	Old River @ Tracy Road Bridge	DWR-CD					

(continued)

Table 1: Proposed modifications to EMP monitoring in D-1641, Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont.Rec.[4]	Cont. Multi-para-meter[5]	Discrete Physical/ Chemical[6]	Discr. Phyto-plank-ton[7]	Discr. Zoo-plank-ton[8]	Dis-crete Ben-thos[9]
MD10	B	Disappointment Slough near Bishop Cut			*	*	*	
S21	C	Chadbourne Slough @ Sunrise Duck Club	DWR-SMP					
S35	B	Goodyear Sl. @ Morrow Is. Clubhouse	DWR-SMP					
S42	**C&B**	Suisun Slough 300' south of Volanti Slough	DWR-SMP		**X**	**X**		
S42A	**B**	**Suisun Slough 300' south of Volanti Slough, center channel**					*	
S49	C	Montezuma Slough near Beldon Landing	DWR-SMP					
S64	C	Montezuma Slough @ National Steel	DWR-SMP					
S97	B	Cordelia Slough @ Ibis Club	DWR-SMP					
NZ032	B	Montezuma Slough, 2nd bend from mouth					*	
SLBAR3	C	Barker Sl. at No. Bay Aqueduct	DWR-O&M					
---	C	Sacramento R. (I St. Bridge to Freeport) (RSAC155)	USGS					
---	B	San Joaquin R. (Turner Cut to Stockton) (RSAN050-RSAN061)	?					
---	B	Water supply intakes for waterfowl management areas on Van Sickle Island and Chipps Island	?					

Symbols (IEP EMP):

*	No change from D-1641
X	**New**
(-)	Moved to neighboring station

Fill patterns & fonts:

No change
Ongoing, but not currently mandated monitoring
New monitoring
Reinstated historical monitoring
Moved to neighboring station
C&B monitoring[2] split between neighboring stations

Acronyms not explained in footnotes: see Table 2

Footnotes:

[1] Most stations use historical "interagency" station identification (ID) numbers as given in SWRCB D-1641 (2000) and D-1485 (1978). Modified station ID numbers (e.g. C3A) identify stations near historical stations. For geographical coordinates see Table 6.

[2] C: Compliance monitoring station; B: Baseline monitoring station , C&B: Compliance and baseline monitoring station (letters replace symbols in D-1641, Table 5)

[3] Most stations use historical "interagency" station descriptions as given in SWRCB D-1641 (2000) and D-1485 (1978). Stations with modified station ID numbers (e.g. D24A) also have modified names to indicate stations near historical stations with similar numbers and names.

[4] Continuous recording (every 15 minutes) of water temperature, EC, and/or dissolved oxygen. For municipal and industrial intake chloride objectives, EC can be monitored and converted to chlorides. Acronyms: station operators for D-1641 stations not operated by the IEP EMP. In parentheses: in D-1485, but not in D-1641.

[5] Continuous multi-parameter monitoring (recording every 1 to 15 minutes with telemetry capabilities) includes the following variables: water temperature, EC, pH, dissolved oxygen, turbidity, chlorophyll fluorescence, tidal elevation, and meteorological data (air temperature, wind speed and direction, solar radiation).

[6] Discrete physical/chemical monitoring is conducted near-monthly on alternating spring and neap tides and includes the following variables: macronutrients (inorganic forms of nitrogen, phosphorus, and silicon), total suspended solids, total dissolved solids, total, particulate and dissolved organic nitrogen and

carbon, chlorophyll *a*, pH, dissolved oxygen (DO), electrical conductivity (EC (specific conductance)), turbidity, light attenuation, secchi depth, and water temperature. In addition, on-board continuous recording is conducted intermittently for the following variables: water temperature, dissolved oxygen, electrical conductivity, turbidity, and chlorophyll *a* fluorescence.

[7] Near-monthly discrete sampling on alternating spring and neap tides for phytoplankton enumeration or algal pigment analysis.

[8] Near-monthly tow or pump sampling for zooplankton, mysids, and amphipods.

[9] In 2003 and 2004, replicated benthos and sediment grab samples are taken quarterly (every three months) and during special studies events; more frequent monitoring sampling resumes in 2005.

Table 2: Proposed IEP EMP baseline monitoring stations not mandated in D-1641.

Station ID[1]	Station Type[2]	Station Description[3]	Cont.Rec.[4]	Cont. Multi-para-meter[5]	Discrete Physical/ Chemical[6]	Discr. Phyto-plank-ton[7]	Discr. Zoo-plank-ton[8]	Dis-crete Ben-thos[9]
NZ325	B	San Pablo Bay near Rock Wall and Light 15					X	
EZ2	B	Entrapment Zone - Location determined when bottom EC values occur @ approximately 2000 us					X	
EZ6	B	Entrapment Zone - Location determined when bottom EC values occur @ approximately 6000 us					X	
YB	B	Yolo Bypass Toe Drain @ DWR screw trap site		X	**X**	**X**		
MI	**B**	**Mildred Island, southern basin**		**X**	**X**	**X**		
TS	B	Threemile Slough	**X (USGS-EMP)**					
MR	**B**	**Mokelumne River Mouth**	**X (USGS-EMP)**					
CB	B	Carquinez Bridge, center channel (north side of center pier)	USGS					
RB	**B**	**Richmond Bridge, center channel**	**X (USGS-EMP)**					

For symbols, fill patterns, and footnotes see Table 1.

Acronyms: (Apply to all Tables)

ID:	Station Identification (instead of "station number")
CR:	Continuous Recorder monitoring, s. footnote 4
MP:	Continuous Multi-Parameter monitoring, s. footnote 5
P/C:	Discrete physical/chemical monitoring, s. footnote 6
P:	Phytoplankton monitoring, s. footnote 7
Z:	Zooplankton monitoring, s. footnote 8
B:	Benthos monitoring, s. footnote 9
DWR-CD:	Monitoring by DWR-Central District
DWR-O&M:	Monitoring by DWR-Division of Operations and Maintenance
DWR-SMP:	Monitoring by DWR-Suisun Marsh Program
DWR-MWQI:	Monitoring by DWR-Municipal Water Quality Investigations Program
NERR:	National Estuarine Research Reserve
USBR-CVO	Monitoring by US Bureau of Reclamation-Central Valley Operations
USGS:	Monitoring by US Geological Survey
USGS-NRP:	Monitoring by USGS National Research Program (Menlo Park)
RMP:	Monitoring by the Regional Monitoring Program of the San Francisco Estuary Institute

Table 3: Proposed new D-1641, Table 6, with additional information.

Station ID[1]	Station Type[1]	Station Description[1]	Latitude[2]	Longitude[2]	RKI[3]	Lead Operator[4]	Alias[5]	Comments[6]
C2	C	Sacramento River @ Collinsville	38.07395	-121.85010	RSAC081	USBR-CVO	Collinsville	Collocated with DWR-SM "Collinsville" station since 2001.
C3A	B	Sacramento River @ Hood	38.36772	-121.52051	RSAC142	IEP-EMP	70	Collocated with DWR-MWQI "HOOD" station. Established in 1998 to replace historical C3 (Green's Landing)
C4	C	San Joaquin River @ San Andreas Landing	38.10319	-121.59128	RSAN032	USBR-CVO	San Andreas	Collocated with DWR-CD station "5100"
C5	C	Contra Costa Canal @ Pumping Plant #1	37.99520	-121.70244	CHCCC006	USBR-CVO	Contra Costa	
C6	C	San Joaquin River @ Brandt Bridge site	37.86454	-121.32270		DWR-CD	5740	
C7A	B	San Joaquin River @ Mossdale Bridge	37.78604	-121.30666	RSAN087	IEP-EMP	10	Replaced historic van station C7
C8	C	Middle River near Old River	37.82208	-121.37517	RMID041	USBR-CVO	Union Island	Historical C8 station description: "In Middle River 1.7 km north of junction with Old River." This station has been moved south and is now at the junction with Old River.
C9	C&B	Clifton Court Forebay @ Radial Gates	37.83075	-121.55703		DWR-O&M	KA000000	Historical C9 used to be just outside of the Forebay on the other side of the levee.
C9-R	B	West Canal @ Mouth of CC Forebay Intake	37.82818	-121.55275	CHWST0	IEP-EMP	C9	C9 - Right bank benthic monitoring
C10	C	San Joaquin River near Vernalis	37.67575	-121.26500	RSAN112	USBR-CVO	Vernalis	
C10A	B	San Joaquin River near Vernalis @ San Joaquin River Club	37.67934	-121.26472		IEP-EMP	Vernalis	New station to be shared by IEP-EMP and DWR-MWQI
C13	C	Mokelumne River @ Terminous	38.11691	-121.49888	RSMKL008	USBR-CVO	Staten Island	USBR description: "Mokelumne River (South Fork) @ Staten Island"
C14	C	Sacramento River @ Port Chicago	38.05881	-122.02607	RSAC064	USBR-CVO	Port Chicago	
C19	C	Cache Slough @ City of Vallejo Intake	38.29687	-121.74784	SLCCH016	USBR-CVO	Cache Slough	Also described as "Cache Slough near end of Hastings cut"
D4	B	Sacramento River above Point Sacramento	38.06214	-121.81792	RSAC084	IEP-EMP		Benthic sampling is done close to the left shore
D6	B	Suisun Bay @ Bulls Head Pt. near Martinez	38.04427	-122.11764	RSAC056	IEP-EMP		Benthic sampling is done at a slightly different location
D6A	B	Sacramento River @ Martinez	38.02762	-122.14052	RSAC054	IEP-EMP	40	

(continued)

Table 3, continued

Station ID[1]	Station Type[1]	Station Description[1]	Latitude[2]	Longitude[2]	RKI[3]	Lead Operator[4]	Alias[5]	Comments[6]
D7	B	Grizzly Bay @ Dolphin nr. Suisun Slough	38.11708	-122.03972	LSBB11	IEP-EMP		
D8	B	Suisun Bay off Middle Point nr. Nichols	38.05992	-121.98996	RSAC068	IEP-EMP		
D9	B	Honker Bay	38.07245	-121.93923		IEP-EMP		Reinstated D-1485 monitoring station
D10	B	Sacramento River @ Chipps Island	38.04631	-121.91829	RSAC075	IEP-EMP		
D10A	C&B	Sacramento River @ Mallard Island	38.04288	-121.92011	RSAC075	IEP-EMP	60	Collocated with DWR-MWQI "Mallardis"
D11	B	Sherman Lake near Antioch	38.04228	-121.79951		IEP-EMP		Reinstated D-1485 monitoring station
D12	B	San Joaquin River @ Antioch Ship Channel	38.02162	-121.80638	RSAN007	IEP-EMP		
D12A	C&B	San Joaquin River @ Antioch	38.01770	-121.80273	RSAN007	IEP-EMP	50	Collocated with USBR-CVO "Antioch", DWR-CD 5020
D15	C	San Joaquin River @ Jersey Point	38.05190	-121.68927	RSAN018	USBR-CVO	Jersey Point	Collocated with USGS-SAC 337190
D16	B	San Joaquin River @ Twitchell Island	38.09690	-121.66912	RSAN024	IEP-EMP		
D19	B	Frank's Tract near Russo's landing	38.04376	-121.61477		IEP-EMP		Reinstated D-1485 monitoring station
D22A	C	Sacramento River NW of Emmaton	38.08406	-121.73912	RSAC092	USBR-CVO	Emmaton	Collocated with DWR-CD 1120
D22	B	Sacramento River @ Emmaton	38.08453	-121.73914	RSAC092	IEP-EMP		
D24A	C&B	Sacramento River below Rio Vista Bridge	38.15891	-121.68721	RSAC101	IEP-EMP	30	Collocated with DWR-CD 1212 and USGS-SAC 455400
D24-L	B	Sacramento River @ Rio Vista, left bank	38.15550	-121.68113		IEP-EMP		D24 - Left bank benthic site
D26	B	San Joaquin River @ Potato Point	38.07667	-121.56696	RSAN035	IEP-EMP		
D28A	B	Old River near Rancho Del Rio	37.97038	-121.57271	ROLD21	IEP-EMP		
D28B	B	Old River @ Bacon Island	37.96980	-121.57210	ROLD024	DWR-CD	5250	Collocated with USGS-SAC 313405 and DWR-MWQI "OLDRIVBACISL"
D29	C&B	San Joaquin River @ Prisoners Point	38.05793	-121.55736	RSAN037	IEP-EMP	80	
D41	B	San Pablo Bay near Pinole Point	38.03016	-122.37287	RSAC032	IEP-EMP		
D41A	B	San Pablo Bay near Mouth of Petaluma R.	38.08472	-122.39067		IEP-EMP		
DMC1	C	Delta Mendota Canal @ Tracy Pump Plt.	37.78165	-121.59050	CHDMC006	USBR-CVO	DMC Headworks	
P8	B	San Joaquin River @ Buckley Cove	37.97815	-121.38242	RSAN056	IEP-EMP		
P8A	B	San Joaquin River @ Rough and Ready Island	37.96277	-121.36587	RSAN058	IEP-EMP	20	Collocated with DWR-CD 5660

(continued)

Table 3, continued

Station ID[1]	Station Type[1]	Station Description[1]	Latitude[2]	Longitude[2]	RKI[3]	Lead Operator[4]	Alias[5]	Comments[6]
P12	C	Old River @ Tracy Road Bridge	37.80493	-121.44929		DWR-CD	5380	
MD10	B	Disappointment Slough near Bishop Cut	38.04229	-121.41935	SLDPT07	IEP-EMP		
S21	C	Chadbourne Slough @ Sunrise Duck Club	38.18476	-122.08315	SLCBN002	DWR-SMP		
S35	B	Goodyear Slough @ Morrow Island Clubhouse	38.11881	-122.09580	SLGYR003	DWR-SMP		
S42	C&B	Suisun Slough 300' south of Volanti Slough	38.18053	-122.04696		DWR-SMP		
S42A	B	Suisun Slough 300' south of Volanti Slough, center channel	38.18027	-122.04779	SLSUS12	IEP-EMP		
S49	C	Montezuma Slough near Beldon Landing	38.18686	-121.97080	SLMZU011	DWR-SMP		
S64	C	Montezuma Slough @ National Steel	38.12223	-121.88800	SLMZU025	DWR-SMP		
S97	B	Cordelia Slough @ Ibis Club	38.15703	-122.11378	SLCRD006	DWR-SMP		
NZ032	B	Montezuma Slough, 2nd bend from mouth	38.16990	-122.02112		IEP-EMP	NZ032	
SLBAR3	C	Barker Slough @ North Bay Aqueduct	38.27474	-121.79499	SLBAR002	DWR-O&M	KG000000	
---	C	Sacramento R. (I St. Bridge to Freeport)			RSAC155			
---	B	San Joaquin R. (Turner Cut to Stockton)			RSAN050-RSAN061			
---	B	Water supply intakes for waterfowl management areas on Van Sickle Island and Chipps Island						

Footnotes for Table 3:

1 See Table C, Footnotes 1-3.
2 Coordinates are geographic North American Datum 1983 and have been verified to be accurate for 1:24,000 scale mapping
3 River Kilometer Index
4 IEP-EMP: Interagency Ecological Program -Environmental Monitoring Program. Other lead operator acronyms: see Table D. The lead operator is responsible for compliance monitoring at compliance stations and for most baseline monitoring and/or station maintenance.
5 Alternative station I.D. used by the lead agency.
6 Comments about additional monitoring by other agencies and station history.

Table 4: Station information summary for proposed EMP stations and for D-1641 stations operated by other programs.

Station ID[1]	Station Type[2]	Station Description[3]	Is this a shore or vessel-based station?[4]	Other monitoring[5]	Does agency flow (F) and/or stage (S) monitoring exist?[6]	Is this a primary or secondary EMP station ?[7]	Analyti-cally link this station with[8]	Move(d) from Station (year)[8]	Study relocation to this primary station[8]	Primary EMP station: flux or ambient?[9]	Primary EMP station: Physical Region[10]	Primary EMP station: Lehman Region[11]	Primary EMP station: Jassby Region[12]	Primary EMP station: Habitat Type[13]
C2	C	Sacramento River @ Collinsville	Shore	USBR		Primary	D4			Ambient	S	LS	SB	TRC
C3A	B	Sacramento River @ Hood	Shore	USBR, DWR-MWQI, USGS	USGS (F) At Freeport: USGS (F&S)	Primary		C3 (MP: 1998, all: 2004)		Flux	S	ND	S	TRC
C4	C	San Joaquin River @ San Andreas Landing	Shore	USBR										
C5	C	Contra Costa Canal @ Pumping Plant #1	Shore	USBR										
C6	C	San Joaquin River @ Brandt Bridge site	Shore	DWR-CD	DWR-CD (S)									
C7A	B	San Joaquin River @ Mossdale Bridge (near C7)	Shore		(S)	Secondary		C7 (1984)	C10A					
C8	C	Old River near Middle River	Shore	DWR-CD										
C9	C	Clifton Court Forebay Radial Gates	Shore	DWR-O&M, DWR-MWQI at Banks P.P.	DWR-O&M (F&S)	Primary	C9A			Flux	SD	SD	D	TRC
C9A	B	West Canal @ Mouth of CC Forebay Intake	Vessel			Secondary	C9		C9					
C10	C	San Joaquin River near Vernalis	Shore (Bridge)	USBR, USGS			C10A							
C10A	B	San Joaquin River near Vernalis @ San Joaquin River Club	Shore	USGS, DWR-MWQI	USGS (F&S)	Primary		C10 (2003)		Flux	SD	SD	SJ	TRC
C13	C	Mokelumne River @ Terminous	Shore	USBR										
C14	C	Sacramento River @ Port Chicago	Shore	USBR		Primary	D8			Ambient	Cell	SB	SB	ESC
C19	C	Cache Slough @ City of Vallejo Intake	Shore	USBR										
D4	B	Sacramento River above Point Sacramento	Vessel	USBR, USGS-NRP, RMP		Secondary	C2		C2					

(continued)

Table 4: Station information summary, continued

Station ID[1]	Station Type[2]	Station Description[3]	Is this a shore or vessel-based station?[4]	Other monitoring[5]	Does agency flow (F) and/or stage (S) monitoring exist?[6]	Is this a primary or secondary EMP station ?[7]	Analyti-cally link this station with[8]	Move(d) from Station (year)[8]	Study relocation to this primary station[8]	Primary EMP station: flux or ambient?[9]	Primary EMP station: Physical Region[10]	Primary EMP station: Lehman Region[11]	Primary EMP station: Jassby Region[12]	Primary EMP station: Habitat Type[13]
D6	B	Suisun Bay @ Bull's Head Pt. near Martinez	Vessel	USGS-NRP		Secondary	D6A		D6B (200?, center channel)					
D6A	B	Suisun Bay @ Martinez	Shore	USGS	EMP (S)	Primary	D6	D6 (1983)	D6B (200?, center channel)	Flux	Sill			ESC
D7	B	Grizzly Bay @ Dolphin near Suisun Slough	Vessel	RMP		Primary				Ambient		SB	SB	EE
D8	B	Suisun Bay off Middle Point near Nichols	Vessel	USBR, USGS-NRP		Secondary	C14		C14					
D9	B	Honker Bay near Wheeler Point	Vessel	RMP		Primary				Ambient		SB	SB	EE
D10	B	Sacramento River @ Chipps Island	Vessel	USGS-NRP		Secondary	D10A							
D10A	C	Sacramento River @ Mallard Island	Shore	USGS, RMP		Primary	D10	D10 (1984)		Flux	CF	SB	SB	EE
D11	B	Sherman Lake near Antioch	Vessel	RMP		Primary				Ambient	CF	WD	UA	FI
D12	B	San Joaquin River @ Antioch Ship Channel	Vessel	RMP		Secondary	D12A							
D12A	C	San Joaquin River @ Antioch Water Works	Shore	DWR-CD, USBR	EMP (S)	Primary	D12	D12 (1984)		Ambient	CF	WD	UA	TRC
D15	C	San Joaquin River @ Jersey Point	Shore	USBR	USGS (F&S)	Primary				Flux	WD			TRC
D16	B	San Joaquin River @ Twitchell Island	Vessel			Primary	D15, D29			Ambient	CD	CD	CD	TRC
D19	B	Franks Tract near Russo's Landing	Vessel	USBR		Primary				Ambient	WD	LSJ	D	FI
D22	C	Sacramento River @ Emmaton	Shore	USBR		Primary	D22A			Ambient	S	LS	S	TRC

(continued)

Table 4: Station information summary, continued

Station ID[1]	Station Type[2]	Station Description[3]	Is this a shore or vessel-based station?[4]	Other monitoring[5]	Does agency flow (F) and/or stage (S) monitoring exist?[6]	Is this a primary or secondary EMP station ?[7]	Analyti-cally link this station with[8]	Move(d) from Station (year)[8]	Study relocation to this primary station[8]	Primary EMP station: flux or ambient?[9]	Primary EMP station: Physical Region[10]	Primary EMP station: Lehman Region[11]	Primary EMP station: Jassby Region[12]	Primary EMP station: Habitat Type[13]
D22A	B	Sacramento River @ Emmaton (near D22)	Vessel			Secondary	D22		D24					
D24	C&B	Sacramento River below Rio Vista Bridge	Shore	USGS, USBR	USGS (F&S)	Primary	D24A			Flux	S	LS	S	TRC
D24A	B	Sacramento River below Rio Vista Bridge, center channel	Vessel	USGS-NRP		Secondary	D24							
D26	B	San Joaquin River @ Potato Point	Vessel			Primary	D16, D29		D29	Ambient	CD	CD	CD	TRC
D28A	B	Old River opposite Rancho Del Rio	Vessel			Secondary	D28B							
D28B	B	Old River at Bacon Island	Shore	DWR-CD	USGS (F&S)	Primary	D28A			Flux	SD	CD	D	TRC
D29	C	San Joaquin River @ Prisoner's Point	Shore		Missing!	Primary	D16, D26			Flux	CD			TRC
D41	B	San Pablo Bay near Pinole point	Vessel	RMP, IEP Bay-Study, USGS		Primary				Ambient	Sill	SPB		BS
D41A	B	San Pablo Bay near the Mouth of the Petaluma River	Vessel	RMP, IEP Bay-Study, USGS		Primary	(USGS CR at channel marker 9)			Ambient		SPB		BS
DMC1	C&B	Delta-Mendota Canal @ Tracy Pump. Plt.	Shore											
P8	B	San Joaquin River @ Buckley Cove	Vessel			Secondary	P8A		P8A					
P8A	B	San Joaquin River @ Rough and Ready Island	Shore	City of Stockton, DWR-CD		Primary	P8	P8 (1983)		Ambient	SD	SD	SJ	TRC
P12	C	Old River @ Tracy Road Bridge	Shore											
MD10	B	Disappointment Slough near Bishop Cut	Vessel			Primary				Ambient	CD	ED	UA	TRC
S21	C	Chadbourne Slough @ Sunrise Duck Club	Shore	DWR-SMP										

(continued)

Table 4: Station information summary, continued

Station ID[1]	Station Type[2]	Station Description[3]	Is this a shore or vessel-based station?[4]	Other monitoring[5]	Does agency flow (F) and/or stage (S) monitoring exist?[6]	Is this a primary or secondary EMP station ?[7]	Analyti-cally link this station with[8]	Move(d) from Station (year)[8]	Study relocation to this primary station[8]	Primary EMP station: flux or ambient?[9]	Primary EMP station: Physical Region[10]	Primary EMP station: Lehman Region[11]	Primary EMP station: Jassby Region[12]	Primary EMP station: Habitat Type[13]
S35	B	Goodyear Sl. @ Morrow Is. Clubhouse	Shore	DWR-SMP										
S42	C	Suisun Slough 300' south of Volanti Slough	Shore	DWR-SMP, NERR (planned)	DWR-SM (S)	Primary	S42A			Ambient				TMC
S42A	B	Suisun Slough 300' south of Volanti Slough, center channel	Vessel			Secondary								
S49	C	Montezuma Slough near Beldon Landing	Shore	DWR-SMP										
S64	C	Montezuma Slough @ National Steel	Shore	DWR-SMP										
S97	B	Cordelia Slough @ Ibis Club	Shore	DWR-SMP										
NZ032	B	Montezuma Slough, 2nd bend from mouth	Shore & Vessel	DWR-SMP	DWR-SM (S)	Primary	S42, S54			Ambient				TMC
---	C	Sacramento R. (I St. Bridge to Freeport) (RSAC155)												
---	B	San Joaquin R. (Turner Cut to Stockton)												
---	C	Barker Sl. at No. Bay Aqueduct (SLBAR3)												
---	B	Water supply intakes for waterfowl management areas on Van Sickle Island and Chipps Island												
NZ325	B	San Pablo Bay near Rock Wall and Light 15	Vessel	RMP		Primary				Ambient				BC

(continued)

Table 4: Station information summary, continued

Station ID[1]	Station Type[2]	Station Description[3]	Is this a shore or vessel-based station?[4]	Other monitoring[5]	Does agency flow (F) and/or stage (S) monitoring exist?[6]	Is this a primary or secondary EMP station ?[7]	Analyti-cally link this station with[8]	Move(d) from Station (year)[8]	Study relocation to this primary station[8]	Primary EMP station: flux or ambient?[9]	Primary EMP station: Physical Region[10]	Primary EMP station: Lehman Region[11]	Primary EMP station: Jassby Region[12]	Primary EMP station: Habitat Type[13]
EZ2	B	Entrapment Zone - Location determined when bottom EC values occur @ approximately 2000 us	Vessel	USGS-NRP		Primary				Ambient				BC
EZ6	B	Entrapment Zone - Location determined when bottom EC values occur @ approx. 6000 us	Vessel	USGS-NRP		Primary				Ambient				BC
YB	B	Yolo Bypass Toe Drain @ DWR screw trap site	Shore	DWR-DES IEP studies section	DWR-O&M (S at Lisbon)	Primary				Ambient	S			FPD
MI	B	Mildred Island, southern basin	Vessel			Primary				Ambient	CD			FI
TS	B	Threemile Slough	Shore	USGS	USGS (F&S)	Primary				Flux	S			TRC
MR	B	Mokelumne River Mouth	Shore		Missing!	Primary				Flux	CD	(CS)		ESC
CB	B	Carquinez Bridge, center channel	Shore		Missing!	Primary				Flux	Cell	(NB)		BC
RB	B	Richmond Bridge, center channel	Shore		Missing!	Primary				Flux	Cell	(SFB)		BC

Footnotes for Table 4, see next page. For agency acronyms, see Table 2.

Footnotes for Table 4:

[1] Most stations use historical "interagency" station identification (ID) numbers as given in SWRCB D-1641 (2000) and D-1485 (1978). Modified station ID numbers (e.g. C3A) identify stations near historical stations. Bold type: part of the proposed EMP station network.

[2] C: Compliance monitoring station; B: Baseline monitoring station , C&B: Compliance and baseline monitoring station

[3] Most stations use historical "interagency" station descriptions as given in SWRCB D-1641 (2000) and D-1485 (1978). Stations with modified station ID numbers (e.g. D24A) also have modified names to indicate stations near historical stations with similar numbers and names.

[4] This is important for monitoring logistics and costs. Continuous monitoring is more readily accomplished from shore and shore-based monitoring may be less costly. It may also indicate how well monitoring results represent local and regional environmental conditions. Vessel-based monitoring usually occurs at a greater distance from shore and may often yield more representative data than shore-based monitoring.

[5] Monitoring by other programs at or in close proximity of EMP stations. For acronyms, see Table D.

[6] The EMP does not monitor flow. Flow monitoring is, however, very important for flux calculations, especially at the designated "flux stations," see footnote 6. We thus propose to more closely collaborate with agencies conducting flow (and stage) monitoring to obtain flow data and help fill gaps in the current flow monitoring network.

[7] Primary EMP stations have continuous monitoring components (reflecting proposed new program emphasis on continuous monitoring) and/or the EMP is the only monitoring program conducting environmental baseline monitoring at these sites. Secondary EMP stations are discrete monitoring stations linked to primary (continuous) sister stations and many may eventually be consolidated with (*i.e.* moved to) the primary stations, if studies show that this will not compromise long-term data continuity.

[8] For improved monitoring efficiency and products, we propose to more closely link continuous and discrete stations and in some cases consolidate stations at the continuous site. These three columns show station integration (links) and proposed future station relocation (moves). We also indicate which continuous monitoring stations have been previously installed in a different location (*i.e.,* moved) than the historical discrete station whose station name they still bear in D-1641, Table 5, with the year of the historical move given in parenthesis.

[9] Ambient stations: track conditions within regions of interest; Flux stations: track conditions and, in association with flow monitoring, mass fluxes across the estuary.

[10] Regions delineated based on geometry, regional scale hydrodynamic transport processes, and hydrologic influences. S: Sacramento River; CF: Confluence region, WD: Western Delta; CD: Central Delta; SD: South Delta; Sill: shallow area in western estuary; Cell: deeper area between sills in western estuary.

[11] Regions according to individual and combined "crisp" hierarchical cluster analysis of monthly data for 14 water quality variables (s. CDWR 1996 and Lehman and Smith 1991 and similar in Jassby and Cloern 2000). Not all stations shown were considered in these analyses. ND: Northern Delta; WD: Western Delta; LSJ: Lower San Joaquin River; LS: Lower Sacramento River; SD: Southern Delta; ED: Eastern Delta; CD: Central Delta; SB: Suisun Bay; SPB: San Pablo Bay. See also Figure 5

[12] Regions based on a "fuzzy" clustering algorithm applied to EMP chlorophyll a data by Alan Jassby (UCD, 2001). SB: Suisun Bay; S: Sacramento; D: Delta; SJ: San Joaquin; UA: unassigned group membership

[13] Regions (habitats) according to ecologically important physical and chemical habitat characteristics. FPD: Floodplain Drain, 2) FI: Flooded Island (shallow lake), TRC: Tidal River Channel, TMS: Tidal Marsh Slough, ESC: Estuarine Channel, EE: Estuarine Embayment, BC: Bay Channel, BS: Bay shoal.

Table 5: Modification description, justification, and future goals for all proposed D-1641 and IEP EMP stations, and footnote revisions for D-1641, Table 5.

Modified Table 5: (Symbols: *:no change; x: added, (-): moved to neighboring station)

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	**Explanations:** Modification description	Justification and outlook
C2	C	Sacramento River @ Collinsville	*						No operational change, but analytical integration of this compliance station with baseline station D4. See also D 4. Obtain funding for multi-depth CR array by the end of the 2003-2005 review cycle	Better integration of existing continuous compliance and discrete baseline stations for improved monitoring products and efficiency. Multi-depth CR array for characterization of vertical temperature and salinity stratification at this deep station. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling.
C3	B	Sacramento River @ Greens Landing			(-)	(-)			See C3A.	See C3A.
C3A	B	Sacramento River @ Hood		*	*	*	X		Discrete P/C & P sampling moved from historical station C3 to the neighboring continuous MP station C3A at Hood. Data comparisons for several variables suggest close agreement between these two sites. However, to ensure data continuity for all variables, conduct side-by-side P/C & P sampling for one year, then discontinue discrete sampling at C3. New station ID and description to indicate different station location from historical station C3 (see proposed new Table 6 for coordinates). Reinstate historical C3 zooplankton sampling at C3A (pump).	Consolidation of existing discrete and continuous stations for improved monitoring products and efficiency. C3A is an important rim station for many monitoring programs. Important flux station (imports into the Delta from the Sacramento River watershed). C3A was established in 1998 near the historical station C3. Reinstated zooplankton sampling to monitor zooplankton entering the Delta from the north and for more comprehensive data analyses and interpretation. A separate special study may investigate cross-channel zooplankton variability to determine potential shore bias.
C4	C	San Joaquin River @ San Andreas Landing	*						No operational change.	
C5	C	Contra Costa Canal @ Pumping Plant #1	*						No operational change.	
C6	C	San Joaquin River @ Brandt Bridge site	*						No operational change.	

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-para-meter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plank-ton[7] (P)	Discr. Zoo-plank-ton[8] (Z)	Dis-crete Ben-thos[9] (B)	Modification description	Justification and outlook
C7A	B	San Joaquin River @ Mossdale Bridge		*					New station ID and description indicates different station location from historical station C7 (see proposed new Table 6 for coordinates). During the 2003-2005 review cycle, study data comparability with C10 and C10A (Vernalis) to assess if this station can be discontinued in favor of a new MP station at Vernalis (C10A).	C7A was established in 1984 near the historical van station C7. The proposed station ID has been used in annual data reports to the SWRCB and indicates a different location from the historical discrete baseline monitoring station C7. The multi-parameter station was established in 1984 near C7and completely replaced discrete monitoring at C7 in 1995. Vernalis is more important to most data users as a "rim station" and has a longer, more comprehensive data record. The MP data record at Mossdale is limited and not extensively used. Mossdale equipment could be used at Vernalis. A recommendation about station discontinuation will be included in the next triennial program review due in 2005.
C8	C	Middle River near Old River	*						No operational change.	
C9	C&B	Clifton Court Forebay @ Radial Gates		X	X	*	X		Formally (re-) adopt continous D-1485 compliance monitoring. Reinstatement of D-1485 discrete P/C sampling. Reinstatement of historical zooplankton (pump) monitoring. Separate station ID and description indicates different location from C9A, see proposed new Table 6 for coordinates.	CR monitoring was likely unintentionally excluded from C9 in D-1641, Table 5, since water quality objectives for Chloride and EC exist at the designated compliance and baseline station C9. Continuos multiparameter and phytoplankton monitoring is currently conducted by DWR O&M. Reinstatement of discrete P/C sampling for QA/QC of continuous measurements and to monitor exports of additional water quality variables. Reinstatement of zooplankton sampling to monitor exports through the water projects.
C9-R	B	West Canal @ Mouth of CC Forebay Intake						*	Analytical integration of existing, but not currently mandated, MP monitoring at C9 with D-1641 baseline benthos monitoring at C9-R, right channel bank. During the 2003-2005 review cycle, investigate if discrete benthos sampling at C9A can be moved to C9 without compromising long-term data continuity.	Better integration and potential consolidation of existing continuous and discrete baseline stations for improved monitoring products and efficiency. A recommendation about station consolidation will be included in the next triennial program review due in 2005. Important station near export pumps, flux station (exports).

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
C10	C	San Joaquin River near Vernalis	X						Formally reinstate D-1485 CR compliance monitoring currently conducted by the USBR.	CR monitoring was likely unintentionally excluded from C10 in D-1641, Table 5, since water quality objectives for EC exist at the designated "compliance and baseline" station C10 and the USBR (CV Operations) has an active CR station at this site.
C10A	B	San Joaquin River near Vernalis @ San Joaquin River Club		X	*	*	X		After side-by-side P/C & P sampling for at least one year, discontinue discrete baseline sampling at historical station C10 and move it to the new Vernalis MP station C10A, slightly north of current C10 (see proposed new Table 6 for coordinates). Separate station ID and description indicates different location from C10. Add zooplankton sampling (pump).	C10 is a "rim station" with a long, comprehensive, highly utilized data record and an important flux station (imports) with high productivity. The new MP station at C10Ais supported by CALFED and will be used and operated by multiple agency groups. It provides a much safer work environment than the increasingly unsafe historical bridge location. It will be the southern counterpart of the Hood station (C3A) on the Sacramento River. Added zooplankton sampling to monitor zooplankton entering the Delta from the south and for more comprehensive data analyses and interpretation. A separate special study may investigate cross-channel zooplankton variability to determine potential shore bias.
C13	C	Mokelumne River @ Terminous	*						No operational change.	
C14	C	Sacramento River @ Port Chicago	*						No operational change. Analytical integration of continuous data from this compliance station with discrete data from baseline station D8. See D8 for details. Obtain funding for multi-depth CR array by the end of the 2003-2005 review cycle.	Better integration and potential consolidation of existing continuous compliance and discrete baseline stations for improved monitoring products and efficiency. Multi-depth CR array to characterize vertical temperature and salinity stratification at this deep "gravitational circulation cell" station. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
C19	C	Cache Slough @ City of Vallejo Intake	*						No operational change.	
D4	B	Sacramento River above Point Sacramento			*	*	*	*	Analytical integration of discrete data from this baseline station with continuous data from compliance station C2. See also C2. During the 2003-2005 review cycle, investigate if discrete sampling at D4 can be moved to C2 without compromising long-term data continuity.	Better integration and potential consolidation of existing continuous compliance station C2 and discrete baseline station D4 at the C2 location for greater monitoring utility and efficiency. A recommendation about station consolidation will be included in the next triennial program review report due in 2005.
D6	B	Suisun Bay @ Bull's Head Pt. near Martinez		(-)	*	*	*	*	Separation of continuous MP monitoring from discrete monitoring at D6 to indicate different station locations, see D6A. Analytical integration of discrete data from this baseline station with continuous data from the neighboring, shore-based MP station D6A. Investigate consolidation with MP station D6A and best location for consolidated station for consideration during the next triennial review. See also D6A.	Better integration and potential consolidation of existing continuous and discrete baseline stations for improved monitoring products and efficiency. Important flux station (exports to San Francisco Bay). A recommendation about station consolidation will be included in the next triennial program review report due in 2005.
D6A	B	Suisun Bay @ Martinez		*					Separate new station ID and description indicates different location from D6, see proposed new Table 6 for coordinates. During the 2003-2005 review cycle, investigate if this continuous baseline monitoring station should be moved to a center channel location through side-by-side sampling and data comparisons. In addition, obtain funding for and test a multi-depth CR array by the end of the 2003-2005 review cycle.	Potential move to new center channel location to avoid shore bias and permit more representative sampling and better integration with USGS and NOAA continuous monitoring of salinity, suspended solids, and flow on Pier 7 of the Benicia Bridge north of the main ship channel. A recommendation about this potential location change and the routine operation of a multi-depth CR will be included in the next triennial program review report due in 2005. Important flux and sill station (exports to Bay) in the western estuary. Multi-depth CR array to characterize vertical temperature and salinity stratification. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling, including SWP & CVP operations forecasts.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
D7	B	Grizzly Bay @ Dolphin near Suisun Slough	X		*	*	*	*	New: moored continuous recorder for EC & Temperature	Long-term benthos station, ambient station representing shallow, open estuarine embayment habitat. Important site for monitoring of the invasive clam *Potamocorbula*
D8	B	Suisun Bay off Middle Point near Nichols			*	*	*		Analytical integration of discrete data from this baseline station with continuous data from compliance station C14. See also C14. During the 2003-2005 review cycle, investigate if discrete P/C & P sampling at D8 can be moved to C14 and zooplankton sampling to a channel site close to C14 without compromising long-term data continuity.	Better integration and potential consolidation of existing continuous compliance and discrete baseline stations for improved monitoring products and efficiency. A recommendation about station consolidation will be included in the next triennial program review report due in 2005. A separate special study may investigate cross-channel water quality and zooplankton variability to assist interpretation of integrated data analysis results.
D9	B	Honker Bay near Wheeler Point	X		X	X			Reinstated D-1485 P/C and P monitoring. New: continuous recorder for EC & Temperature.	Ambient station representing ecologically important shallow estuarine embayment habitat
D10	B	Sacramento River @ Chipps Island		(-)			*		Separation of continuous MP monitoring from discrete monitoring at D10 to indicate different station locations, see D10A for details. Improved analytical integration of discrete zooplankton data from this baseline station with continuous data from shore-based MP station D10A.	Better integration of existing continuous and discrete baseline stations for improved monitoring products and efficiency. A separate special study may investigate cross-channel water quality and zooplankton variability to assist interpretation of integrated data analysis results.
D10A	C&B	Sacramento River @ Mallard Island		*	X				Separate new station ID and description indicates different location from D10, see proposed new Table 6 for coordinates. Reinstatement of discrete D-1485 P/C sampling conducted during sensor maintenance. Obtain funding for multi-depth CR array by the end of the 2003-2005 review cycle.	Reinstatement of discrete P/C sampling for QA/QC of continuous measurements. Multi-depth CR array to characterize vertical temperature and salinity stratification. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
D11	B	Sherman Lake near Antioch	X		X	X			Reinstated D-1485 P/C monitoring. New: phytoplankton monitoring and continuous recorder for EC & Temperature.	Ambient monitoring in flooded island (shallow lake) habitat. Of proposed flooded island sites, D11 is the "leakiest" and closest to the confluence / estuarine transition zone.
D12	B	San Joaquin River @ Antioch Ship Channel		(-)			*		Separation of continuous MP monitoring from discrete monitoring at D12 to indicate different station locations, see D12A for details. Improved analytical integration of discrete zooplankton data from this baseline station with continuous data from shore-based MP station D12A-1983.	Better integration of existing continuous and discrete baseline stations for improved monitoring products and efficiency. A separate special study may investigate cross-channel water quality and zooplankton variability to assist interpretation of integrated data analysis results.
D12A	C&B	San Joaquin River @ Antioch Water Works		*	X				Separate new station ID and description indicates different location from D12, see proposed new Table 6 for coordinates. This station was listed as D12* in D-1485. Reinstatement of D-1485 station description and P/C sampling. P/C sampling will be conducted during sensor maintenance. Obtain funding for multi-depth CR array by the end of the 2003-2005 review cycle.	Reinstatement of discrete P/C sampling for QA/QC of continuous measurements. Multi-depth CR array to characterize vertical temperature and salinity stratification. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling.
D15	C	San Joaquin River @ Jersey Point	*						No operational change. New: analytical integration of data from this USBR-operated station into comprehensive EMP data analyses.	D-1641 compliance station for EC operated by USBR O&M. USGS measures flow here. Important for cross-Delta mass flux calculations. EMP will acquire data from USBR and USGS for flux analyses.
D16	B	San Joaquin River @ Twitchell Island					*	*	No operational change. New: analytical association of D16 discrete monitoring data with continuous and discrete monitoring data from stations D29 and D15.	Long-term zooplankton "index" station. Improved analytical integration of data from existing continuous and discrete monitoring stations for improved monitoring products. A separate special study may investigate water quality and zooplankton variability between stations near D16 to assist interpretation of integrated data analysis results.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
D19	B	Franks Tract near Russo's Landing	X		X	X	X		Reinstated D-1485 P/C and Z monitoring station. Reinstated historical (1975-1979, 1988-1995) P monitoring. New: CR monitoring.	Ambient monitoring in flooded island (shallow lake) habitat. "Leaky," shallow lake in the Western Delta with high SAV and *Corbicula* densities and low algal biomass.
D22A	C	Sacramento River NW of Emmaton	X						No operational change, but formally reinstate D-1485 CR compliance monitoring at existing shore station operated by DWR O&M (EC1120).	CR monitoring at D22A was likely unintentionally excluded from D-1641, Table 5, since water quality objectives for EC exist at the designated compliance and baseline station D22.
D22	B	Sacramento River @ Emmaton					*		Separate new station ID and description indicates (very slightly!) different location from D22A, see proposed new Table 6 for coordinates. Improved analytical association of D22 discrete zooplankton monitoring data with continuous and discrete monitoring data from continuous shore station D22A and D24. See also D22A and D24.	Long-term zooplankton "index" station. Improved analytical integration of data from existing continuous and discrete monitoring stations for improved monitoring products. As separate special study, investigate cross-channel zooplankton variability between D22A and D22 to assist interpretation of integrated data analysis results. Also investigate if D22 zooplankton monitoring can be replaced by reinstated D24 zooplankton monitoring without compromising long-term data continuity.
D24A	C&B	Sacramento River below Rio Vista Bridge		*	X				New: discrete P/C sampling. New station ID to distinguish continuous MP monitoring from discrete monitoring at historical D24.	Discrete P/C sampling for QA/QC of continuous measurements, to improve benthos data interpretations and to provide additional relevant data. Important flux and compliance station.
D24-L	B	Sacramento River below Rio Vista Bridge, left bank						*	Separate new station ID and description indicates different location from D24A, see proposed new Table 6 for coordinates. Improved analytical integration of benthos baseline monitoring data from discrete channel station D24 with data from near-by, shore-based MP station.	Benthos station on left channel bank. Better integration of existing continuous and discrete baseline stations for improved monitoring products. A separate special study may investigate cross-channel water quality and benthos variability to assist interpretation of integrated data analysis results. Investigate moving D22 zooplankton monitoring to this station.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
D26	B	San Joaquin River @ Potato Point			*	*	*		No operational change. New: analytical association of D26 discrete monitoring data with continuous and discrete monitoring data from stations D16 and D29. During the 2003-2005 review cycle, investigate if sampling at D26 can be moved to D29 without compromising long-term data continuity. See also D29.	Long-term zooplankton "index" station. Better integration and potential consolidation of existing discrete baseline and continuous compliance stations for improved monitoring products and efficiency. A recommendation about station consolidation will be included in the next triennial program review report due in 2005.
D28A	B	Old River near Rancho Del Rio	(-)		*	*	*	*	Separation of CR baseline monitoring from discrete monitoring at D28A to indicate different station locations, see D28B for details. New: analytical integration of discrete data from channel station D28A with data from near-by, shore-based continuous station D28B (=EC5250) operated by DWR (Central District). During the 2003-2005 review cycle, investigate if D28A and D28B monitoring can be consolidated at D28B location without compromising long-term data continuity.	Flux station, long-term benthos station. Better integration and potential consolidation of existing continuous and discrete baseline stations for improved monitoring products and efficiency. A recommendation about the consolidation of these stations will be included in the next triennial program review report due in 2005.
D28B	B	Old River at Bacon Island	*						New station ID and description for the shore-based continuous station near D28A operated by DWR, Central District (EC5250). In collaboration with DWR-CD, attempt to obtain funding for station expansion to include MP monitoring by the end of the 2003-2005 cycle.	Formally propose continuous MP monitoring at this station for adoption into the water right decision in the next triennial program review report due in 2005.

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Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
D29	C&B	San Joaquin River @ Prisoners Point	*		X	X	X		Seasonal CR monitoring station expanded to year-around operation with new discrete sampling of P/C, P, and Z. Attempt to obtain funding for station expansion to include MP monitoring by the end of the 2003-2005 review cycle.	Important flux station, northern endpoint for Stockton Ship Channel D.O. monitoring. Analytical association of D29 continuous data with discrete data collected at D26 and D16. Discrete sampling at D29 may eventually replace discrete sampling at D26 (and possibly D16), see D26.
D41	B	San Pablo Bay near Pinole Point			*	*	X	*	No operational change, but formal addition of ongoing Z monitoring.	Though not required in D-1641, zooplankton has been monitored here since 1998. This site is not suitable for continuous monitoring. Hydrodynamically important sill station in the western estuary.
D41A	B	San Pablo Bay near Mouth of Petaluma River			X	X	X	*	Expand to include discrete sampling of PC, P, and Z. Analytical integration of discrete data from D41 A with continuous data from near-by USGS-operated CR station at Channel Marker 9 (turbidity, EC, temperature). Investigate data comparability between these sites to assist interpretation of integrated data analysis results.	Long-term benthos station. Ambient station representing shoal habitat with fluctuating salinity levels. Important site for monitoring of the invasive calm *Potamocorbula*. Better integration of existing continuous and discrete baseline stations for improved monitoring products. Include recommendation about formal adoption of the USGS CR station at channel marker 9 for adoption into the water right decision in the next triennial program review report due in 2005.
DMC1	C	Delta-Mendota Canal @ Tracy Pump. Plt.		*					No operational change.	
P8	B	San Joaquin River @ Buckley Cove		(-)	*	*	*	*	Separation of continuous MP monitoring from discrete monitoring at P8 to indicate different station locations, see P8A for details. Improved analytical integration of discrete baseline monitoring data from discrete channel station P8 with data from near-by, shore-based MP station. During the 2003-2005 review cycle, investigate if discrete sampling at P8 can be moved to P8A without compromising long-term data continuity.	Station integration and potential consolidation improves monitoring products and efficiency. A recommendation about the consolidation of stations P8 and P8A will be included in the next triennial program review report due in 2005. See also P8A .

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Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
P8A	B	San Joaquin River @ Rough and Ready Island		*					No operational change. Separate new station ID and description indicates different location from P8, see proposed new Table 6 for coordinates.	Important San Joaquin River station near southern endpoint for Stockton Ship Channel D.O. monitoring. Frequently occurring D.O. sags, high productivity. Data extensively used by CVRWQCB.
P12	C	Old River @ Tracy Road Bridge	*						No operational change.	
MD10	B	Disappointment Slough near Bishop Cut			*	*	*		No operational change. Attempt to obtain funding for station expansion to include CR monitoring by the end of the 2003-2005 review cycle.	Ambient station, the only eastern Delta representative, smaller "backwater" tidal river channel
S21	C	Chadbourne Slough @ Sunrise Duck Club	*						No operational change.	
S35	B	Goodyear Sl. @ Morrow Island Clubhouse	*						No operational change.	
S42	C&B	Suisun Slough 300' south of Volanti Slough	*		X	X			New: discrete P/C & P sampling.	Discrete P/C and P sampling for QA/QC of continuous measurements, to improve interpretation zooplankton data collected at S42A, and to provide additional relevant data. Ecologically important tidal marsh slough habitat with long-term monitoring history. Planned in vicinity: NERR site.
S42A	B	Suisun Slough 300' south of Volanti Slough, center channel					*		Separate new station ID and description indicates different location from S42, see proposed new Table 6 for coordinates. Improved analytical integration of zooplankton baseline monitoring data from discrete channel station S42A with data from near-by, shore-based CR station S42.	Long-term zooplankton station. Improved analytical integration of data from existing continuous and discrete monitoring stations for improved monitoring products. A separate special study may investigate water quality and zooplankton variability between S42 and S42A to assist interpretation of integrated data analysis results.
S49	C	Montezuma Slough near Beldon Landing	*						No operational change.	
S64	C	Montezuma Slough @ National Steel	*						No operational change.	
S97	B	Cordelia Slough @ Ibis Club	*						No operational change.	

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
NZ032	B	Montezuma Slough, 2nd bend from mouth					*		No operational change. New: Improved analytical association of zooplankton data with data from continuous recorder stations S49 and S54 operated by DWR -Suisun Marsh program	Improved analytical integration of data from existing continuous and discrete monitoring stations for improved monitoring products. As separate special study, investigate zooplankton variability at and between the three Montezuma Slough sites to assist interpretation of integrated data analysis results and evaluate station consolidation potential. Ecologically important tidal marsh slough habitat.
SLBAR3	C	Barker Sl. at No. Bay Aqueduct	*						No operational change.	
---	C	Sacramento R. (I St. Bridge to Freeport) (RSAC155)	*						No operational change.	
---	B	San Joaquin R. (Turner Cut to Stockton) (RSAN050-RSAN061)	*						No operational change.	
---	B	Water supply intakes for waterfowl management areas on Van Sickle Island and Chipps Island	*						No operational change.	
NZ325	B	San Pablo Bay near Rock Wall and Light 15					X		Monthly sampling and formal addition of existing, ongoing Z monitoring to D-1641 baseline monitoring.	Long-term zooplankton station to monitor zooplankton export to the SF Bay and X-2 relationships, currently sampled only when surface EC is < 20,000 µs.
EZ2	B	Entrapment Zone - Location determined when bottom EC values occur @ approximately 2000 us					X		No operational change, but formal addition of ongoing Z monitoring to D-1641 baseline monitoring.	Long-term zooplankton station, important for tracking of X2 relationships.
EZ6	B	Entrapment Zone - Location determined when bottom EC values occur @ approximately 6000 us					X		No operational change, but formal addition of ongoing Z monitoring to D-1641 baseline monitoring.	Long-term zooplankton station, important for tracking of X2 relationships.
YB	B	Yolo Bypass Toe Drain @ DWR screw trap site		X	X	X			Formal addition of ongoing MP, P/C, and P monitoring to D-1641 baseline monitoring, expansion from seasonal to year-round station.	Represents ecologically important flood plain habitat with agricultural use during the dry season. Ongoing DWR fish monitoring. The proposed new station ID is consistent with the names of the other MP stations.

(continued)

Table 5, continued

Station ID[1]	Station Type[2]	Station Description[3]	Cont. Rec.[4] (CR)	Cont. Multi-parameter[5] (MP)	Discrete Physical/ Chemical[6] (P/C)	Discr. Phyto-plankton[7] (P)	Discr. Zoo-plankton[8] (Z)	Discrete Benthos[9] (B)	Modification description	Justification and outlook
MI	B	Mildred Island, southern basin		X	X	X			New MP (CR and algal fluorescence), P/C, and P baseline monitoring station.	Ambient monitoring in flooded island (shallow lake) habitat. "Lakey" shallow lake in the Central Delta with low SAV and *Corbicula* densities and high algal biomass, occasional algal blooms. The proposed new station ID is consistent with the names of the other MP stations.
TS	B	Threemile Slough	X						New CR baseline monitoring at USGS flow monitoring station in collaboration with USGS.	Important for cross-Delta mass flux calculations because of exchanges between the Sacramento and San Joaquin Rivers through Threemile Slough. May eventually be expanded to MP station.
MR	B	Mokelumne River Mouth	X						New collaborative USGS-EMP CR baseline and flow monitoring station.	Important for cross-Delta mass flux calculations because of Delta Cross Channel operations & central Delta tributary (Mokelumne & Cosumnes) inflows.
CB	B	Carquinez Bridge, center channel (north side of center pier)	X						Formal addition of ongoing, multiple depth, CR baseline monitoring station operated by the USGS to D-1641 baseline monitoring in collaboration with USGS.	Important flux and gravitational circulation cell station in the western part of the estuary, ongoing USGS monitoring of EC, temperature, flow and suspended solids.
RB	B	Richmond Bridge, center channel	X						New CR baseline monitoring station in collaboration with USGS. Replaces IEP-funded USGS "Point San Pablo" CR station. Obtain funding for multi-depth CR array by the end of the 2003-2005 review cycle.	Important flux and gravitational circulation cell station in the western part of the estuary, ongoing USGS monitoring. Multi-depth CR array for characterization of vertical temperature and salinity stratification at this deep station. This is important for understanding ecological and hydrodynamic transport processes and for meaningful numerical modeling.

For symbols and footnotes see next page. For additional acronyms, see Table 2.

Table 5, Symbols:

*	:	no change
X	:	added
(-)	:	moved to neighboring station

Table 5, Footnotes:

= Proposed revised footnotes for D-1641 Table 5.

Changes from D-1641, Table 5:
- Individual footnotes added for each table column.
- New column 2 to clarify symbols in D-1641 (2000), Table 5.
- All other changes: Updates and clarifications.

All footnote text modifications indicated by **bold print!**

[1] **Most stations use historical "interagency" station identification (ID) numbers as given in SWRCB D-1641 (2000) and D-1485 (1978). Modified station ID numbers (e.g. C3A) identify stations near historical stations. For geographical coordinates see Table 6.**

[2] **C: Compliance monitoring station; B: Baseline monitoring station , C&B: Compliance and baseline monitoring station.**

[3] **Most stations use historical "interagency" station descriptions as given in SWRCB D-1641 (2000) and D-1485 (1978). Stations with modified station ID numbers (e.g. D24A) also have modified names to indicate stations near historical stations with similar numbers and names.**

[4] **Continuous recording (every 15 minutes) of water temperature, EC, and/or dissolved oxygen.** For municipal and industrial intake chloride objectives, **electrical conductivity (EC) can be monitored and converted to chloride concentrations.**

[5] **Continuous multi-parameter monitoring (recording every 1 to 15 minutes with telemetry capabilities) includes the following variables: water temperature, EC, pH, dissolved oxygen, turbidity, chlorophyll fluorescence, tidal elevation, and meteorological data (air temperature, wind speed and direction, solar radiation).**

[6] **Discrete physical/chemical monitoring is conducted near-monthly on alternating spring and neap tides and includes the following variables: macronutrients (inorganic forms of nitrogen, phosphorus, and silicon), total suspended solids, total dissolved solids, total, particulate and dissolved organic nitrogen and carbon, chlorophyll *a*, pH, dissolved oxygen (DO), EC (specific conductance), turbidity, secchi depth, and water temperature. In addition, on-board continuous recording** is conducted intermittently for the following variables: water temperature, dissolved oxygen, electrical conductivity, turbidity, and chlorophyll *a* fluorescence.

[7] **Near-monthly discrete sampling on alternating spring and neap tides for phytoplankton enumeration or algal pigment analysis.**

[8] **Near-monthly tow or pump sampling for zooplankton, mysids, and amphipods.**

[9] **In 2003 and 2004, replicated benthos and sediment grab samples are taken quarterly (every three months) and during special studies events; more frequent monitoring sampling resumes in 2005.**

Table 6: Prioritized Monitoring Activities during the 2003-2005 SWRCB and 2003-2007 IEP Review Cycles (Priority level resets each year)

Priority level	Monitoring Activity	Justification	Staff Need	Other Resource Needs	Implementation start date (year) or period
N/A in progress	Improved EMP data and information management and reporting	Fulfills program objectives 6 and 7, and provides the basis for fulfilling all other program objectives	30% of one ES IV, 50% of one ES III, 15% of one WREA and two ES I	Dedicated server, consultant time for software development and web based reporting tools, GIS and spatial analysis software	Started 2001, ongoing task
N/A in progress	Initiate establishment of Conductivity-Temperature (CT) twin sensors at proposed new Continuous Recorder Stations and the center-channel Benicia Bridge location, and work with USBR, DWR-CD, DWR-SMP, and USGS on joint station collaboration and coordination	The increased emphasis on continuous monitoring better accounts for temporal and spatial variability in salinity and water temperature at all time scales.	100% of two CST I/II and 50% of one boat operator during station installation (six months) 25% of one CST I/II and one boat operator for stations maintenance	CT sampling equipment and associated hardware (already purchased). Dedicated boat, foul weather gear (CT sensors for vertical array at D6/40A (Benicia Bridge) have already been purchased.)	Started in 2002 (continue in Years 1 - 2)
1	Replace annual data report with web-based reporting tools and "status and trends" summary report to SWRCB & in IEP newsletter. For 2002, submit reports in both old and new formats to ease transition and test new format.	Value of the monitoring program is greatly increased if timely information is made available to the broadest audience	50% of one ES III, 25% of three ES I/II year-around	Consultant time for software development and web based reporting tools, GIS and spatial analysis software	Year one (2003) (continue indefinitely as routine part of EMP)
2	Begin discrete sampling on alternating spring/neap tides	Reduces biases associated with variability arising from the spring-neap cycle	No additional staff is needed, but field work may be increased by an undetermined amount due to some loss in sampling flexibility	None	Year one (2003) (continue indefinitely as routine part of EMP)
3	Implement quarterly instead of monthly benthos sampling during two-year study period; Dedicate section staff to benthic ecology research and reporting; keep more informative field notebook Return to more frequent sampling in year 3.	Frees up staff and resources for urgently needed benthos special studies; generates greater staff expertise; suitability of current design unclear due to lack of appropriate data (esp. need higher spatial resolution data!)	None	None	Years one and two (2003-2004)
4	Initiate station consolidation at C3/C3A and (as soon as C10A has been built) at C10/C10A according to Table F. Ensure data continuity for all variables through side-by-side discrete sampling for one year, then discontinue sampling at historical discrete stations C3 and C10. Reinstate historical zooplankton sampling at C3A (pump).	The continuous data stream is considered superior to discrete monitoring of basic water quality conditions, and concomitant discrete sampling of additional variables would be beneficial. Staff and resource savings from combining discrete and continuous sites will be applied to other areas within the program.	No additional staff needed. Some training of CST I/II staff maintaining continuous sites to ensure proper collection and storage of discrete samples.	Zooplankton pump sampling equipment.	Years one and 2 (2003-2004)
5	Initiate year-round operation of station D29 (instead of seasonal). Procure funding for expansion to central Delta multi-parameter station, and implement as soon as possible. Initiate discrete WQ, phyto-, and zooplankton sampling. Compare data with data from D26 and D16.	Important central Delta location. Year-around operation of this station could also obviate the need for discrete monitoring stations D26 and D16 if data comparability is sufficient, allowing reallocation of staff and resources to other efforts.	Somewhat expanded continuous station maintenance effort for year-round CR operation. 20% of Sr. CSE for planning and permitting associated with establishment of a new multiparameter station house.	Multiparameter station: Depending on siting of new station house $50,000 - $75,000 may be required for construction of a new station.	Year one (2003); expand station in year 3-5 if funding is available
1	Initiate modification of discrete monitoring elements according to Table F. Add a near-bottom dissolved oxygen and temperature sensor at station P8.	Better spatial coverage and sampling of under-represented habitat types, better integration of monitoring components, quality control for continuously monitored constituents	Depending on exact implementation, we expect a 30% increase in staff field time. Assuming two staff, this would equate to 6 staff days per month.	Some sample storage or collection equipment may be required to deal with sample collection and transit.	Year two (2004) (continue in Years 3 and 4)

(continued)

Table 6: Prioritized Monitoring Activities, continued

Priority level	Monitoring Activity	Justification	Staff Need	Other Resource Needs	Implementation start date (year) or period
2	Start reporting constituent fluxes at flux stations with available flow data, and phytoplankton primary productivity estimates (using K_d/TSS/turbidity and chl. *a*).	Informative data used for food web and hydrodynamic modeling, productivity budgets, etc.	No additional staff needed.	None	Year two (2004) (continue indefinitely as routine part of EMP)
3	Start changing sampling and analytical procedures based on outcomes of special studies	Methods may have to be adjusted to include state-of-the-art procedures and instrumentation to assure highest-quality data and information	Depends on outcome of special studies	Possibly new instrumentation	Year two (2004) (continue in Years 3 - 5)
1	Evaluate EMP revisions and consider adjustments to revisions and implementation schedule in triennial SWRCB review report due December 2005	First formal reality check - Implementation of numerous changes to a multifaceted program is difficult. Adjustments will need to occur along the way. Triennial review is required in D-1641, Condition 11 e.	No additional staff needed.	None.	Year three (2005)
2	Reconsider benthos monitoring design based on insights from year 1 – 2 special studies, reinstate more frequent benthos monitoring. Start routinely measuring benthos biomass according to outcome of special study.	Benthos monitoring reduced in Yeasr 1 & 2, needs to be reestablished. Propose modified design in 2005 triennial review report to SWRCB	10% time of two ES and two supervisors for over one year.	None	Year three (2005) and following years.
3	Increase focus on adding to and updating EMP Metadata files (including "BioGuide" files, if special study to initiate this effort is funded)	Reference information, QA/QC	30% ESI or II, with help from SciAide	None	Year three (2005) (continue indefinitely as routine part of EMP)
4	With funding in place, modify continuous monitoring station D29 from seasonal to year-around operation	s. year 1	20% of Sr. CSE for establishing new station. 5% of CST I/II year-around for station maintenance	s. year 1	Year three (2005)
1	Continue ongoing monitoring efforts from Years 1-3, and evaluate allocation of staff effort to revised EMP and consider adjustments to implementation schedule to ensure a balance between field work, data management, and data analysis and reporting	Continued implementation with ongoing reality check.	20% time of two ES and two supervisors for over one year.	None	Year four (2006) (continue in Year 5)
2	Start implementing monitoring activities recommended in 2005 triennial review report to the SWRCB, if approved. They may include additional station consolidations, additions, and discontinuations.	Further program improvements based on monitoring and special studies results from Years 1-3.	To be determined.	To be determined.	Year four (2006) (continue in Year 5)
1	Initiate next IEP EMP review cycle	Compliance with regular IEP review cycles.	20% time of two ES and two supervisors for over one year.	None	Year five (2007)

Table 7: Prioritized Special Studies during the 2003-2007 IEP Review Cycle (Priority level resets each year)

Priority level	Special Study	Justification	Staff Need	Other Resource Needs	Implementation start date (year) or period
N/A in progress	Phytoplankton monitoring procedures	Long-term continuity and QA/QC of monitoring data (discrete and continuous chlorophyll *a*, phytoplankton composition & abundance), concerns about current methods, QA/QC, interest in related measures (primary productivity, C:Chl. *a* ratios, etc.)	Two ES 15%, one ESA, 15%, one SciAide, 30%, 3 years	Historical data, contract with USGS phytoplankton consultant (in place), access to lab, instruments, boat, some supplies (filters, etc.)	Started in 2001, ongoing through 2004
N/A in progress	Zooplankton monitoring procedures	Ongoing study to assure efficient and safe coordination with Bay study and overall sampling improvements	One ES 30%, 1 year (funded by IEP, extension pending)	Boat access, nets, etc.	Started in 2002, IEP funding, ongoing through 2004
1	Spatial and temporal design of EMP phytoplankton monitoring	Need a representative, efficient monitoring design for a highly complex system - Based on historical data and considering current station placement, what is the most appropriate spatial and temporal design for EMP phytoplankton monitoring?	One Staff ES 30%, 3 years	Collaboration with UCD; Advanced statistical skills & computer software (A. Jassby lead, approved CALFED funding)	Year one (likely start June 2003) (continue in Years two and three)
2	Spatially intensive benthos sampling in the Delta	Need higher resolution information about benthos variability across the Delta to better design benthos monitoring. Joint ("piggy-back") study with ongoing Calfed study by Jan Thompson, USGS.	2 ES, 20% for one year. Will use EMP funding freed up by reducing benthos monitoring from monthly to quarterly.	Collaboration with USGS; Glass storage vials, modification to benthic taxonomy contract	Year one (2003), Continue with more focussed studies, see below
3	Initiate a series of studies to determine the lateral or longitudinal variability of affected constituents in areas where station shifts and consolidations at continuous monitoring sites are proposed. Start with existing data and with shifts at Martinez (D6 and D6A versus center channel location), see Table F.	Before moving stations, comparability between the two sites needs to be established to ensure continuity of the valuable long-term data record. Predetermined standards to assess how well continuity can be assumed will be developed.	Two ES 15% per year and two Sci aids 100% time per year	CT sampling equipment and associated hardware for comparisons involving new continuous recorder stations. Dedicated boat, foul weather gear.	Year one (2003) (continue in Years two and three)
4	Initiate studies to test conceptual model for predicting spatial water quality patterns with data from the network of continuous monitoring sites located within tidal excursion ranges of each other	Need to find out more about the potential homogenizing influence of (large) tidal excursions on water quality, and the influence of "local" processes. Will use horizontal profiling with continuous instrumentation and discrete sampling along transect, possibly remote sensing	Two ES III or IV 15% per year and one Sci aid 100% time per year, collaboration with USGS	Access to boat, continuous recording instruments, lab, possibly remote sensing images	Year one (2003) (continue in Years two and three)
5	Initiate a series of special studies to evaluate procedural improvements following recommendations by the SATs and SAG during the EMP review	Methods may have to be adjusted to include state-of-the-art procedures to assure highest-quality data and information	Various field, lab and office staff	Filed and lab gear, possibly new instrumentation, collaboration with DWR Bryte lab	Year one (2003) (continue in Years two to four)
1	Benthos studies: Benthos Bio Guide (species descriptions), Benthos Biomass, and comprehensive long-term data analyses at long-term sites	Species descriptions and biomass are needed for comprehensive, process-oriented analyses. Comprehensive analysis and synthesis of existing data will provide information necessary to develop a more effective monitoring design	Several ES and collaborators, variable time. Additional study funding for 2004 will be requested from CALFED due to IEP's budget shortfall.	Collaboration with experts; Glass storage vials, modification to benthic taxonomy contract	Year two (2004) (possibly apply for funding to continue these studies in Years two and three; or if funding rejected, apply again/elsewhere)

(continued)

Table 7: Prioritized Special Studies, continued

Priority level	Special Study	Justification	Staff Need	Other Resource Needs	Implementation start date (year) or period
2	Utility of Remote Sensing	Readily affordable and available satellite imagery could provide high-resolution spatial variability data for several constituents (temperature, suspended solids, phytoplankton (blooms), etc.) for a system wide (or synoptic) view of Bay-Delta water quality	Two ES and UCSC collaborator (Prof. Raphael Kudela). Vessel crew time. Total funding requested from IEP: $29,200.-. Possibly need other funding source.	Landsat TM scenes at $600 per scene, vessel access, software	Year two (2004) (possibly apply for funding to continue in Years two and three; or if funding rejected, apply again/elsewhere)
3	Initiate interagency (DWR, USBR, and USGS) review of upper estuary continuous monitoring network	Reduction of continuous monitoring network redundancy could generate substantial efficiencies among agency programs. Network integration could also result in more straightforward data reporting. Standard operating procedures will provide more comparable data.	One EPM I 10% and one Sr. CSE 20% for one year. Time for USBR and USGS staff is also needed.	None	Year two (2004)
4	Development of an analytical water clarity model linking water quality to remote sensing in the Bay-Delta	Light limits algal growth in the upper estuary and is a major cause for phytoplankton variability. This study investigates how to best monitor light and primary productivity related variables. Superficially addressed by remote sensing study, above, but more substantial study preferred: CALFED postdoctoral fellowship application by T. Swift, UCD, rejected - will be resubmitted for CALFED ERP funding.	Postdoc with expertise in physical limnology/oceanography; one ESIII, 20% (or GS12), one Sci Aid, full-time, plus field assistance, 3 years	Access to various radiometers, turbidimeters, particle (size) counter, electron microscope, etc., - may be done in collaboration with university researchers, CALFED funding	Year two (2004) (continue in Years three and four)
1	Focussed studies of benthic variability in various habitats and along spatial gradients.	Overlooking non-channel habitats and cross- or along-channel variability has been recognized as a shortcoming of the program; study results will contribute to improved benthos monitoring design and data analyses	ESIII lead staff to coordinate study, 30% time, and field crew, boat staff (10%), 3 years	Non-standard sampling gear, identification and enumeration of sample fauna, boat time for survey and sampling; possibly graduate student or postdoc	Year three (2005) (continue in Year four)
2	Special study to evaluate sampling bias associated with tidal phase aliasing – the “slow boat” effect	Sampling over changing tidal phases introduces a form of aliasing into the discrete data that should be accounted for. It may be that no boat is able to reach sampling stations in the delta at the same point on the tide due limitations in operating a vessel in public waters. However, a quantitative evaluation will at least allow documentation of the issue & help interpret historical EMP data.	Two boat operators and four ES for two field days each season over one year. 20% time of one ES to manage and analyze the resulting data.	Requires two existing boats and associated discrete sampling equipment.	Year three (2005)
3	Two-year, pilot monitoring of BOD, size-fractionated chlorophyll a, and continuous flow and in vivo chlorophyll a fluorescence, at stations C3 and C10.	Monitoring these constituents in a coordinated way may provide information that can improve our understanding of delta food web dynamics and how the foundation of the food web changes over time.	30% of two USGS techs. for 3 months to establish ADCP equipment at station 22. 20% of one CST I/II for two weeks to establish a fluorometer at station 9. 5% more staff time during discrete sample collection and for analysis.	Fluorometer, ADCP, maybe some additional lab costs for BOD sample analysis	Year three (2005) (continue in Year four, evaluate in year five)
1	Evaluate need for monitoring of non-algal aquatic producers through a comprehensive customer and monitoring program survey	Relevance of monitoring; Other groups could all be important producers, affected by flow, important resource effects (e.g. macrophytes as "ecosystem engineers"), hardly anything known about them in the Delta	ESIII, 10%, SciAide, 40%		Year four (2006)

Fig.1: Proposed EMP station network. (D1641 EMP Stations (blue symbol fill color): EMP compliance and baseline stations in the proposed modified D-1641 Table 5 (see Table A). IEP-EMP Baseline Stations (yellow symbol fill color): Proposed EMP baseline stations not mandated in D-1641 (see Table B). Station pairs (e.g. D10-D10A): Neighboring stations located at a distance of no more than 2 miles from each other and proposed for consolidation or analytical integration. Continuous Stations: Continuous measurement of important variables complemented in most cases by discrete monitoring of additional variables. Multi-Depth: Vertical arrays of continuously recording probes at two or more depths. Single-Depth: Continuously recording probes at 1-m depth below the water surface. Discrete Sampling Only: Stations without continuous recording instrumentation. Please note that Tables A-D also list D-1641 stations that are not part of the proposed EMP station network. These stations are operated by other agency groups as indicated in Table 1.)

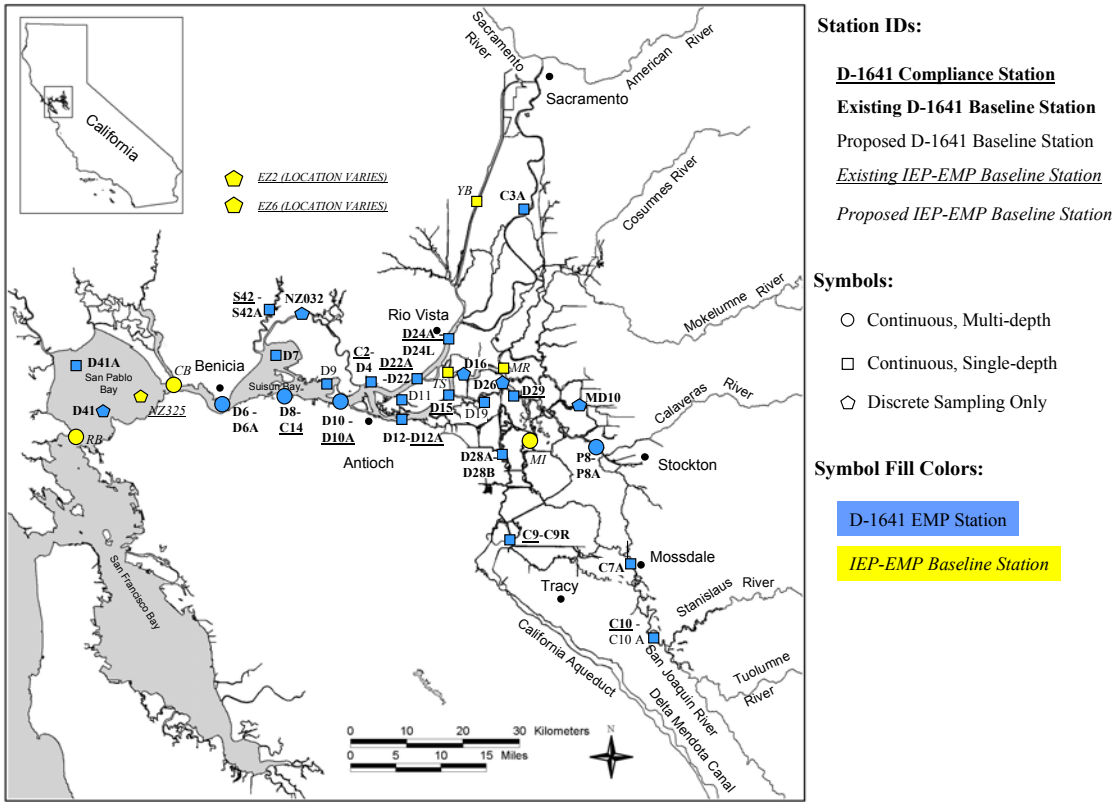
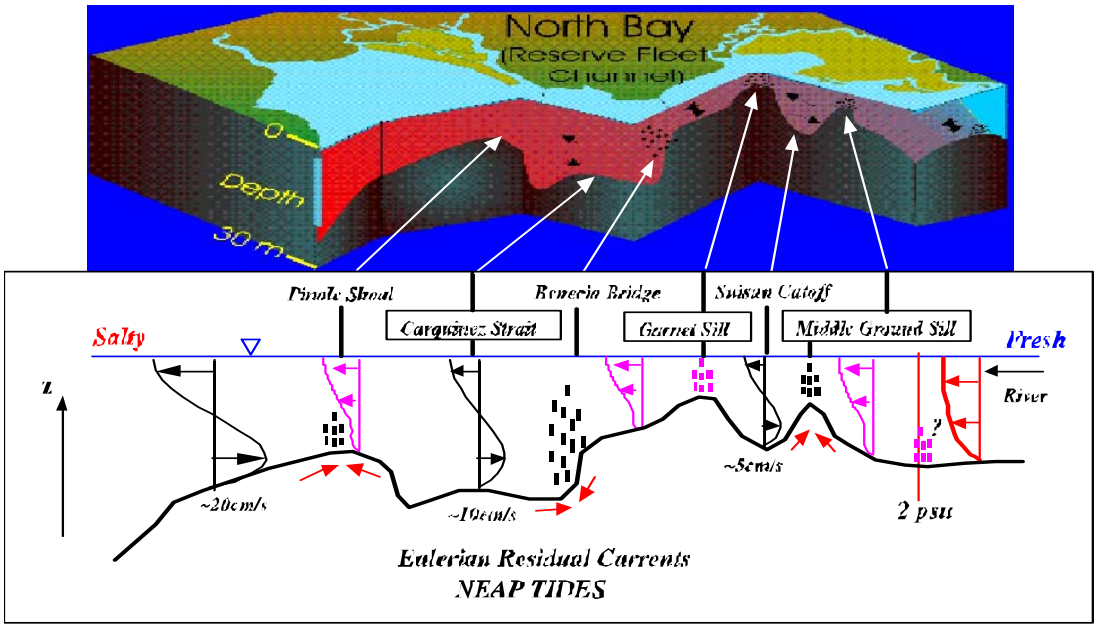
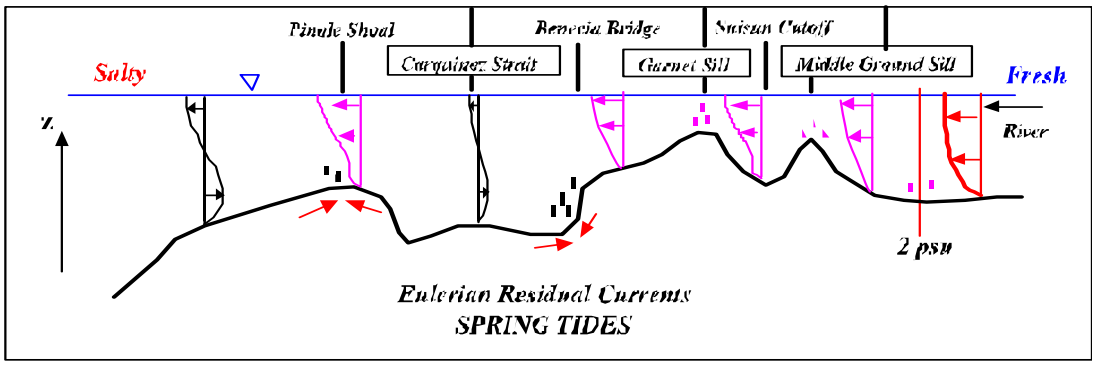


Fig. 2: Conceptual model of Eulerian residual circulation for San Pablo and Suisun bays and Carquinez Strait. This model emphasizes the importance of bottom topography (bathymetry) and the difference between conditions that occur during neap and spring tides and provides the basis for EMP continuous station placement in these areas. (Data and graphics: J. Burau, USGS)





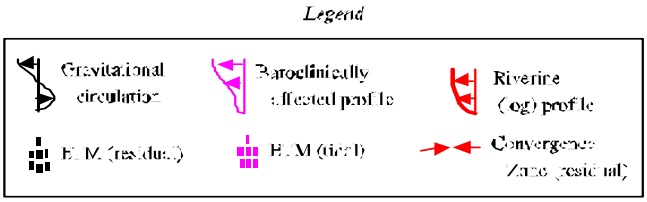


Fig 3: Numerical simulation of the Sacramento River influence on the Delta. This image was generated by introducing Sacramento River water into the simulation with concentrations of one (red) over a simulation of 35 days. Sacramento River water was allowed to move throughout the Delta under the prevailing hydrologic conditions in August-September 2001. The concentrations throughout the Delta were initially set to zero (blue). This simulation emphasizes the importance of physical processes in determining Delta regions and the high degree of spatial variability among regions and between and within similar habitat types. Modified from simulation and graphics by N. Monsen, USGS Menlo Park. (Broken white lines: boundaries between physically defined Delta regions; S: Sacramento River; CF: Confluence region, WD: Western Delta; CD: Central Delta; SD: South Delta)

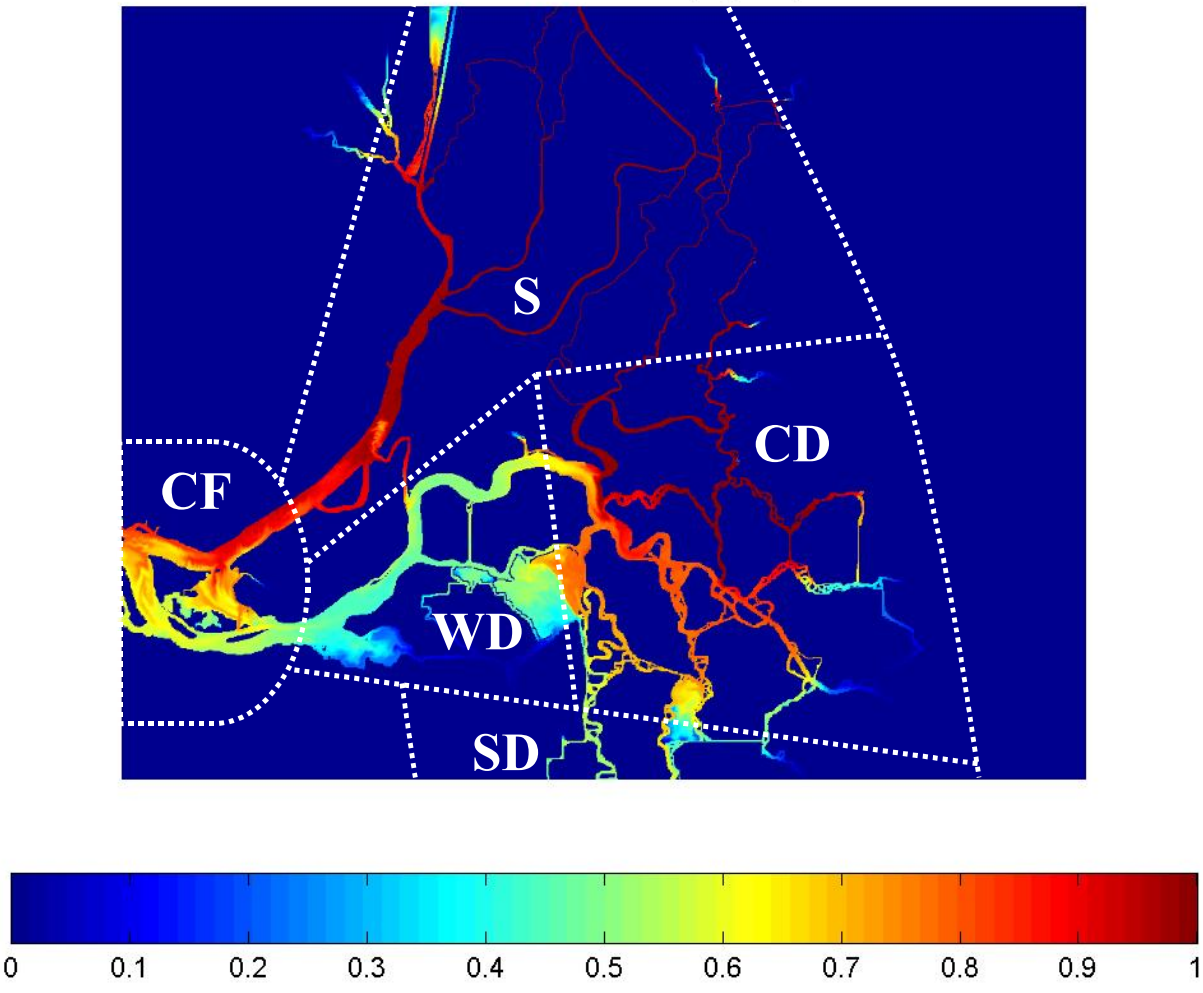
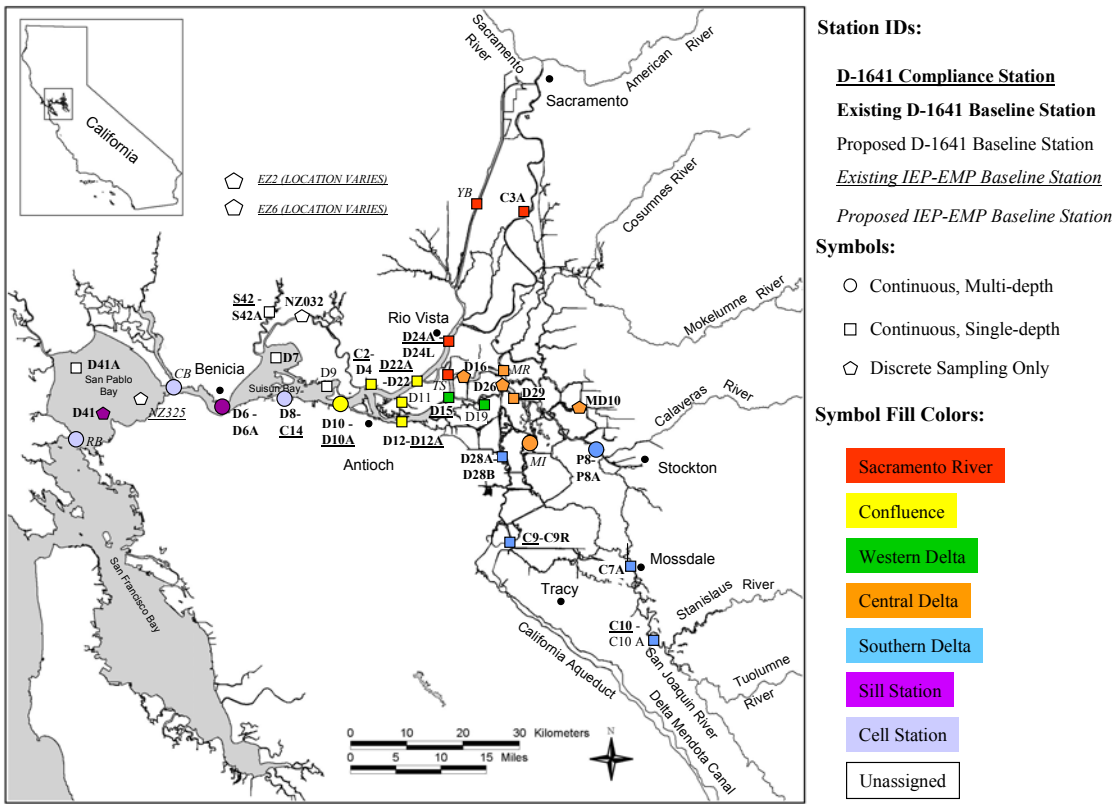


Fig. 4: Recommended EMP stations with their associated bathymetric features in Suisun Bay and San Pablo Bay and physically defined Delta regions. (Bathymetric features: shallow "sills" and deeper gravitational circulation "cells", s. Fig. 3; Delta regions: based on geometry, regional scale hydrodynamic transport processes, and on hydrologic influences, s. Fig. 4; for details about station IDs and symbols, s. Fig. 1.)



Station IDs:

D-1641 Compliance Station

Existing D-1641 Baseline Station

Proposed D-1641 Baseline Station

Existing IEP-EMP Baseline Station

Proposed IEP-EMP Baseline Station

Symbols:

○ Continuous, Multi-depth

□ Continuous, Single-depth

⬠ Discrete Sampling Only

Symbol Fill Colors:

Sacramento River

Confluence

Western Delta

Central Delta

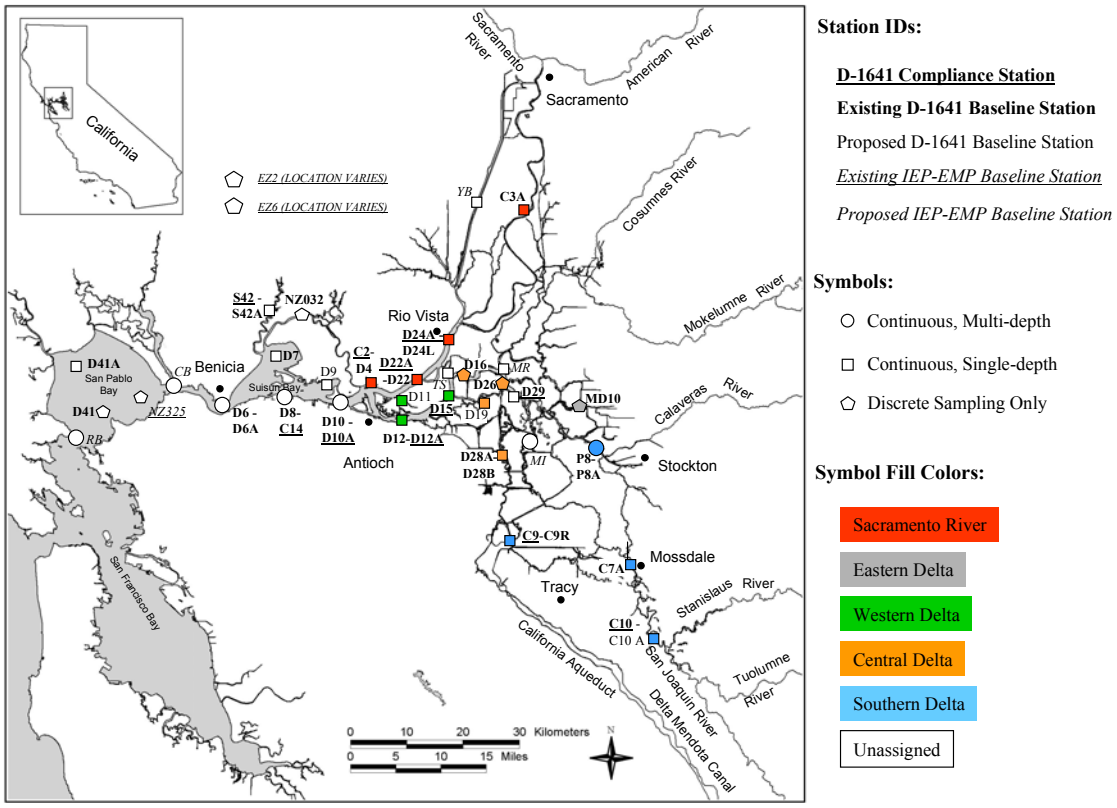
Southern Delta

Sill Station

Cell Station

Unassigned

Fig. 5: Stations associated with Delta regions determined statistically from EMP water quality data (Lehman 1996 and Jassby & Cloern 2000). For details about station IDs and symbols, s. Fig. 1.



Station IDs:

D-1641 Compliance Station

Existing D-1641 Baseline Station

Proposed D-1641 Baseline Station

Existing IEP-EMP Baseline Station

Proposed IEP-EMP Baseline Station

Symbols:

○ Continuous, Multi-depth

□ Continuous, Single-depth

⬠ Discrete Sampling Only

Symbol Fill Colors:

Sacramento River

Eastern Delta

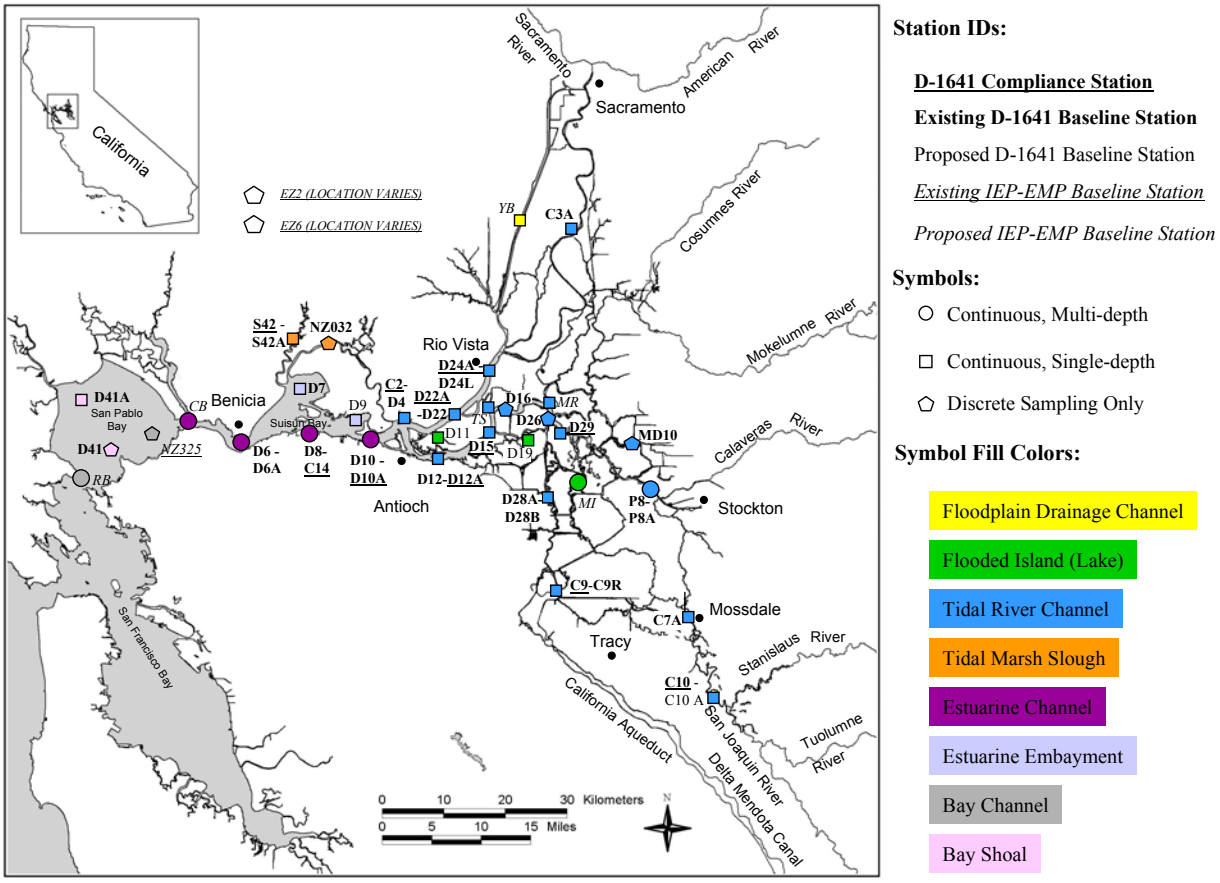
Western Delta

Central Delta

Southern Delta

Unassigned

Fig. 6: Habitat types represented by the proposed EMP stations. (For details about station IDs and symbols, s. Fig. 1.)



Station IDs:

D-1641 Compliance Station

Existing D-1641 Baseline Station

Proposed D-1641 Baseline Station

Existing IEP-EMP Baseline Station

Proposed IEP-EMP Baseline Station

Symbols:

○ Continuous, Multi-depth

□ Continuous, Single-depth

⬠ Discrete Sampling Only

Symbol Fill Colors:

Floodplain Drainage Channel

Flooded Island (Lake)

Tidal River Channel

Tidal Marsh Slough

Estuarine Channel

Estuarine Embayment

Bay Channel

Bay Shoal

Fig. 7: Proposed ambient and flux stations. Arrows: main water flows through the Delta, Suisun Bay, and San Pablo Bay. (For Details about Station IDs and Symbols, s. Fig. 1.)

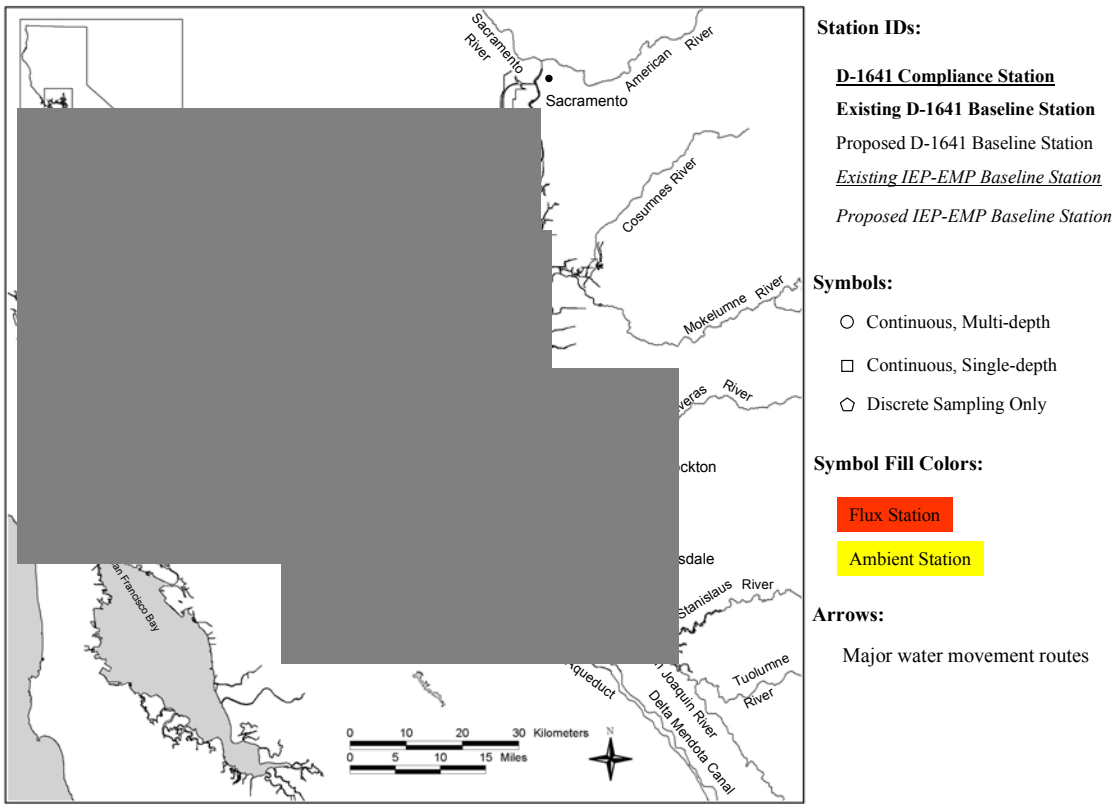


Fig. 8: "Slack water plot:" Preliminary estimates of tidal excursions at fixed USGS flow stations (red lines emanating from yellow dots) and special studies stations (blue lines emanating from blue dots). Data and graphics: J. Burau, USGS.

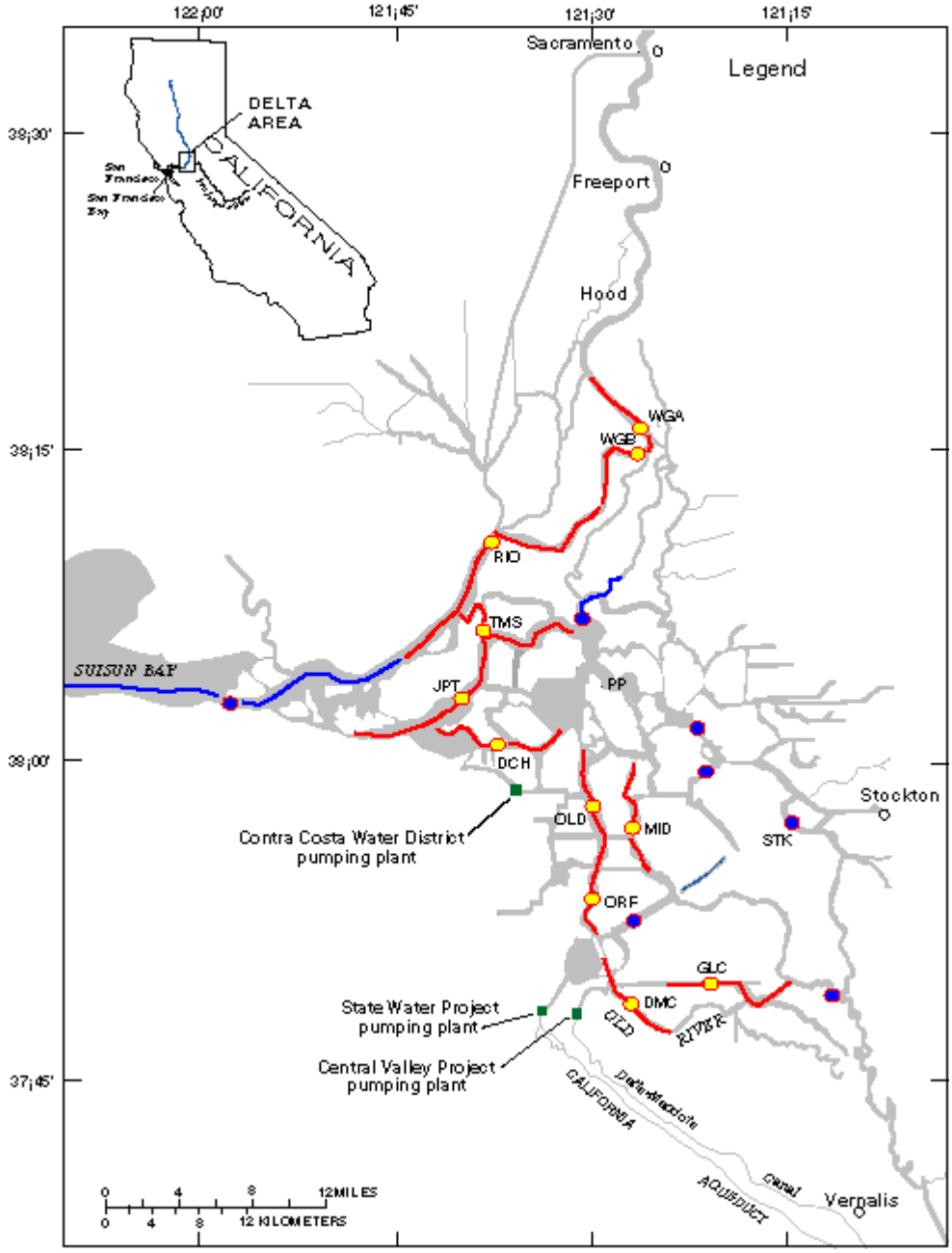
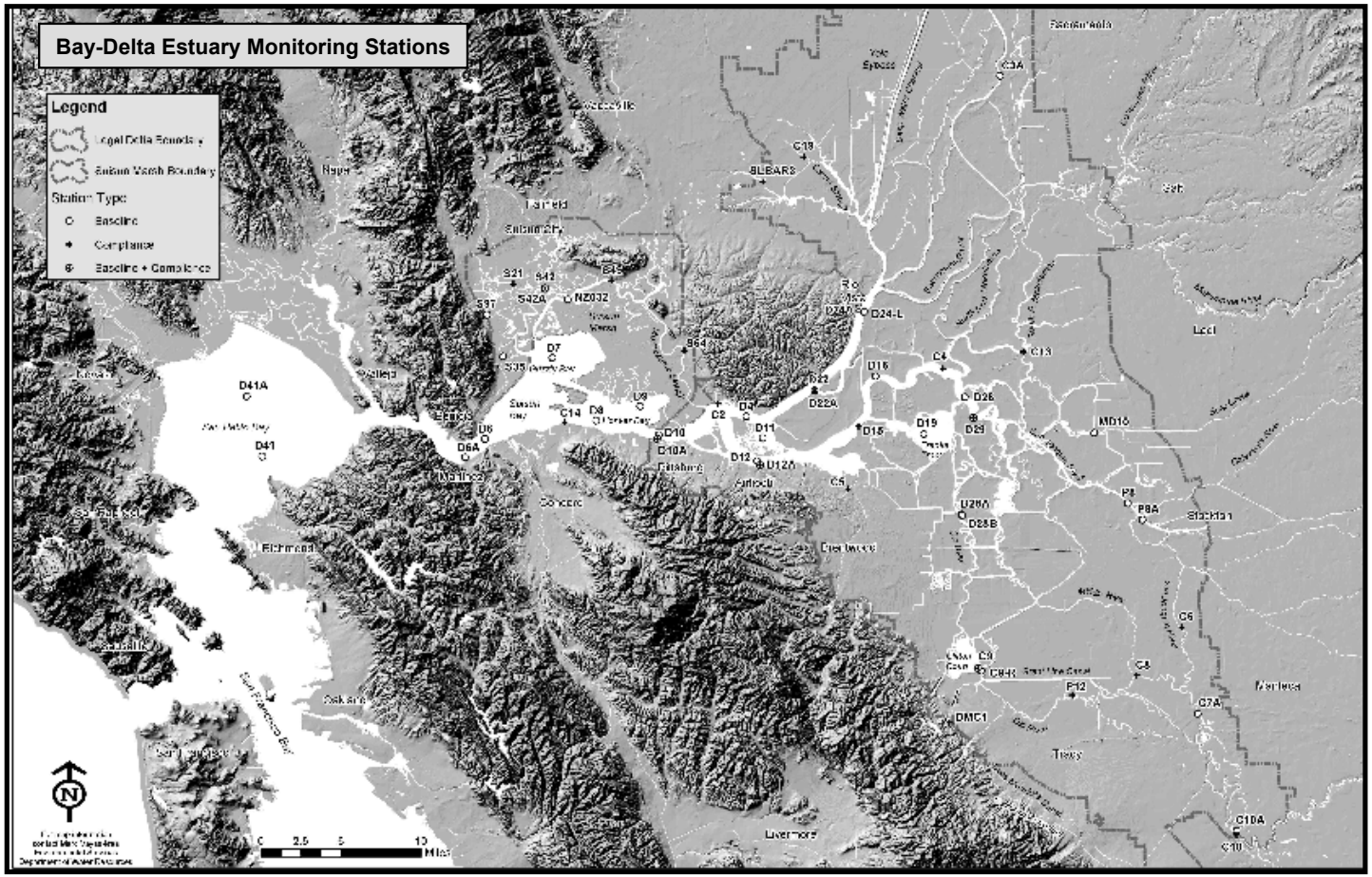


Fig. 10: Proposed revised D-1641 Figure 4 (D-1641, p.194) based on geographic coordinates for all stations. Coordinates are geographic North American Datum 1983 and have been verified to be accurate for 1:24,000 scale mapping



Please note: This is a very low-resolution representation of the proposed Figure 4 prepared by EMP staff based on the geographical station coordinates in Table G. Higher quality images are available at http://iep/emp/EMP_Review_Final.html.

II. Response Summary in Tables

Table A: 2002 IEP SAG Review of the EMP – Introduction

Praise for the EMP	SAG comments	EMP response
Uninterrupted operation for > 30 yr.s leading to one of the longest, most valuable water quality-biological monitoring records in the US, will become even more valuable over time because of fast, high-impact changes to the B-D system. Comprehensive, visionary. Useful for both managers & scientists to understand the impact of human activities against the background of natural changes.	Carry on! (unanimous endorsement of EMP)	We appreciate the support.
Self- & outside evaluation to address management needs & critical uncertainties (2001-2 review)	Good idea, & done admirably well so far…	We appreciate the support.

Constraints for review/recommendations	SAG comments	EMP response
Legal mandate to provide data for four general information needs (to monitor compliance with EC & DO, document trends of change in living resources, & provide data for models)	Large-scale structural changes would be inappropriate	These are our main program goals, and provide the boundaries for defining the scope of the EMP. All program objectives and questions are derived from these.
Finite (limited) resources	Expansion of scale & scope inappropriate	We agree, are aiming for resource reallocation within existing EMP budget and are pursuing additional IEP or CALFED funding for equipment purchase & special studies. Would prefer guaranteed additional funding for special studies to ensure a substantially improved monitoring design for all EMP elements by the end of the current review cycle. Will free up EMP funding for essential benthos studies through temporary reduction of benthos monitoring from monthly to quarterly sampling.

Table B: 2002 IEP SAG Review of the EMP - General Review

No.	Areas for EMP improvement	SAG comments/recommendation	EMP response
1	**Data & products:** *Use of data to develop useful products; Accountability for data & information quality through product dissemination & peer review*	Primary SAG recommendation: Increase "human intellectual investment" to improve data quality & utility and thus overall value of the program! Main EMP product: information about status and trends in the B-D system. EMP data should be rapidly interpreted in relation to spatial & temporal trends as well as conceptual models & theories integrating results from all program elements. Results & interpretation should also be published in peer-reviewed journals etc. This can be done by IEP scientists and/or outside collaborators. Good examples: data analysis and publications from zooplankton element, Peggy Lehman's work with phytoplankton/chlorophyll data.	We agree. We are already attempting some improvements, e.g. web-based, geo-referenced information reporting tools, improved meta-data linked to the web-based data base, etc. Also, the EMP has recently increased its "human intellectual investment" by hiring four scientists with Ph.D. degrees dedicated to data synthesis, interpretation, dissemination, and program design and procedural improvements. We hope to foster an environment where all program staff is encouraged to participate in both monitoring and EMP related special studies in all subject areas, including appropriate reporting in newsletters, journals, etc. This is not always an easy thing to do given the realities of public employment. Patience is required.
2	**Specify questions & aims** *underlying EMP data collection for individual sub-programs and the whole program (esp. benthos & phytoplankton monitoring)*	These questions should be germane to the original reasons for initiating EMP and will guide EMP design by constraining sampling choices. Suggested aims from ADJ: 1. Station continuity; 2. Mass balance estimation; 3. System-wide averages with sampling stratification by magnitude and appropriate stratum representation. 4. Mechanisms underlying system wide dynamics. 5. Habitat type characterization. 6. Compliance (legal stations). 7. Modeling (boundary stations)	We propose a hierarchy of goals, objectives, and questions of increasing specificity and decreasing application breadth. The mandated program goal is given in D-1641 and by the IEP mission. The objectives are based on our current understanding of system hydrodynamics and ecology and guide the program design. The specific questions address particular areas important for D-1641 compliance, resource managers and for a better understanding of the system, and should be answered routinely as part of the program's products. For more detail, see the narrative response.
3	**Integration among program elements** *encompassing conceptual, sampling design, and analytical & interpretation aspects of the program, possibly using new integrative tools such as remote sensing*	Needs to be much more explicit, otherwise "a critical opportunity is missed" to interpret ecological processes and interactions using EMP data. Core stations = integration sites? Some SAG members think that remote sensing should be explored to better integrate EMP data on a spatial basis (e.g. chlorophyll fluorescence, turbidity, DOC).	We will use hydrodynamic and ecological conceptual models to better link program elements in the overall EMP design and as a basis for data analysis and interpretation for all program elements. In particular, continuous monitoring data will be closely linked in real time with (USGS) flow data and visualizations to estimate spatial structure of variables at various temporal scales based on knowledge of tidal transport of water parcels. Discrete monitoring data will be superimposed and, if possible, extrapolated based on knowledge of hydrodynamics and local processes. More variables will be monitored concomitantly at the proposed stations. Long-term stations will be designated to ensure continued and especially comprehensive monitoring and data analyses, and non-channel habitat types will be better represented. Remote sensing may also be explored for spatial integration of EMP data (pending IEP funding). Long-term analyses will include data from all program elements. For more detail, see narrative response.

Table B: 2002 IEP SAG Review of the EMP - General Review, cont.

No.	Areas for EMP improvement	SAG comments/recommendation	EMP response
4	**Benthos monitoring:** *specify questions/aims and monitoring design*	Identify objectives that incorporate biological response measures that best integrate & define natural & anthropogenic changes, and how this information will be used for management models & decisions	We developed the following plan to address these concerns: 1) During a two-year study period, monitor benthos quarterly at the ten stations listed in Table 1; resume monthly sampling thereafter. 2) With the newly formed IEP Benthos Estuarine Ecology Team (BEET) and the IEP EET, develop recommendations for specific program questions/objectives and alternative methods based on reviews of other benthos monitoring programs and consultations with managers, scientists, and others. 3) Conduct targeted special studies and consider results of new and ongoing CALFED work to better understand spatial variability on a local and regional scale and, allocate sample effort. The newly formed IEP BEET should guide benthos investigations. Also conduct method comparison studies, if needed. 4) Collaborate with outside experts on more comprehensive analyses of existing data and conduct additional special studies to increase available information and aid in the development of recommendations for redesign of the program. 5) Develop specific recommendations for program questions/objectives and a revised monitoring design, and present them to IEP management and the SWRCB for review/approval during the next review cycle. We expect the IEP BEET to play an important role in formulating these recommendations for benthos monitoring.
5	**Phytoplankton monitoring** *specify questions/aims and monitoring design and address laboratory analysis procedural issues.*	The availability, quality and value of the phytoplankton data are substantially less than they could be. The existing data set is potentially rich in information content that has not been fully utilized. Better definition of objectives is needed. Evaluate/improve enumeration procedures and possibly reduce/realign data collection effort devoted to this program element. Improve data availability.	We generally agree with the SAG comments. We are already studying procedural shortcomings and considering alternatives. Data availability is being addressed together with all our other data base work. We are working to re-define objectives/aims.
6	**Sampling design**		
6a	*Spatial EMP design*	Should be based on specific questions/goals for sub-programs; Because these are not sufficiently defined, SAG won't make recommendations. Instead recommends to first identify specific goals or aims for each program element, and then to conduct a series of IEP special studies with analyses of existing data to identify appropriate spatial design to attain goals. Different goals may require different programs that potentially conflict, & not all may be attainable with existing resources	We propose a fixed-station spatial program design based on physical and ecological conceptual models of the estuary and maintaining the long-term continuity of the historical stations. Physically, we separate the Bays and Delta into distinct regions based on geometry, on the influence of regional scale hydrodynamic transport processes, and on hydrologic influences. Ecologically, we distinguish eight habitat types. "Ambient" stations represent all identified regions and habitat types, while "flux" stations (include flow measurements) are located at regional boundaries to assess regional exchanges. Ultimately, all stations should have continuous sensors and be located within one tidal excursion range of each other to enable estimates of day-to-day spatial structure. This will enable spatially intense data analyses.
6b	*Temporal EMP design*	Endorsement of WQ SAT plan to shift emphasis to continuous sampling using modern submersible instrumentation with data telemetry; do this in concert with flow measurements to enable assessment of constituent transport rates; also consider adding instruments to measure chl. a, suspendend sediment, & DO.	We appreciate the support and agree with the SAG recommendations. Our approach is to start by establishing continuous monitoring stations with the most robust sensors (i.e., EC and temperature) first and build from there.
6c	*Continuous monitoring sites*	Recommended for mass balance & model boundaries, habitat index stations, and locations in high gradients	We concur and have designated stations in our proposed spatial design accordingly, see figures.

Table B: 2002 IEP SAG Review of the EMP - General Review, cont.

No.	Areas for EMP improvement	SAG comments/recommendation	EMP response
6d	*Discrete monitoring sites*	"Fill-in" sites for supplementing continuous sites to discern region-wide behavior. Frequency: depends on aims - better define aims for each program element, see above. Spring-neap cycle needs to be taken into account (to determine long-term means: alternate S-N sampling; to determine seasonal patterns: sampling always at same S-N stage)	We concur. Since we are more interested in long-term trends (according to our primary goal & mandate), we opt for alternate spring-neap sampling of discretely sampled variables. Overall, we propose to physically or analytically integrate all discrete sites with neighboring continuous sites.
6e	*Discrete monitoring at continuous monitoring sites*	As a QC check of continuous measurements & for variables without continuous sensors	We concur and will take discrete samples during routine station maintenance scheduled around alternating spring-neap tides.
6f	*Station redundancies with other programs*	Reduce redundancy for greater efficiency. One helpful product: a comprehensive interagency database suitable for GIS query & display. Should be easy to assemble.	We will explore station redundancies among continuous monitoring stations. Alas, a comprehensive database is not easy to assemble, as ongoing efforts (e.g., IEP Bay-Delta Tributaries database, "BDAT") have shown. Also, interagency data comparability may be a problem, as well as an agency willingness to give up redundant stations. We are now working on our own sub-database with cross-links. We have also recently assembled geographic coordinates for EMP and other water quality monitoring stations in the estuary to enable georeferenced data queries (see also Table 3)

Table C: 2002 IEP SAG Review of the EMP: Additional Comments by individual SAG members

SAG member	Recommendation	EMP response
Jon Sharp:		
Methodological considerations & improvements for several water quality variables	DO, pH, fluo. probe maintenance & calibration needs to be done in very specific ways, otherwise data is worthless	We are certainly aware of this. We think we are using appropriate procedures, but we do need to complete written SOPs for peer-review by Jon Sharp & others and with links to the EMP database. Also, the calibration data should be available with the monitoring data (as meta-data).
	TDS is useless because it reflects a mix of inorganic (salt) ions & organic compounds. EC should be measured instead and converted to salinity (I.e. inorganic TDS).	We are able to convert these data to estimates of salinity. We will further consider the recommendation to discontinue measuring TDS.
	Particulate C (& N) should be measured directly rather than as VSS (after cross-calibration)	We are currently discussing this with chemists in our water quality laboratory and will develop final recommendations for the next triennial review.
	DOC measurements should be added	We intend to do this.
	TDN measurements (simultaneous with DOC) should be added & replace TKN which is analytically flawed (unreliable oxidation) and DON	We will discuss this with chemists in our water quality laboratory and will develop final recommendations for the next triennial review.
	Fluorometric analysis rather than spec. analysis should be used for extracted chl. a analysis because it's more sensitive & faster (less filtering).	We will discuss this with chemists in our water quality laboratory and experiment with an existing spare Turner 10 AU fluorometer.
	Phytoplankton: microscopic enumeration for few select samples, HPLC analysis for more samples, chl. a for all samples, plus remote sensing for widest areal coverage.	We will first evaluate our procedural problems (in progress, will be summarized in IEP newsletter article). We will also investigate a new multi-wavelength submersible fluorometer (in progress) and talk to Dick Dougdale about his new flow cytometers. We are also pursuing remote sensing.
Terry Short:		
How will benthic organisms be used as bioindicators of environmental change? What specific measures will be used to characterize change in space & time? What will be used as baseline/reference conditions?	One possible approach: habitat suitability models for targeted native or exotic species based on species-specific environmental optima along environmental gradients	Interesting approach. First we need to work to clarify the questions/aims for the benthos monitoring program. Then we will come back to experts like Terry Short to design a program that best answers the questions. We will encourage and participate in discussions by the new IEP BEET.
Integration with other program elements, and relevance of appropriate scale: Benthos responds to local (near-bed) events & processes while EMP focuses more on regional variability. How can this be reconciled? What are the main overall questions?	Identify program objectives/specific questions that integrate processes operating at multiple scales.	Yes, this is the first step we need to take. We will work on this with the IEP BEET.
Does the current benthos monitoring element fulfill program goals (identified as above)? Would it be feasible to replace counting of replicate samples with composite samples? Does the EMP WQ data adequately characterize conditions affecting benthos at regional & local scales? What have we learned?	Conduct comprehensive review & analysis of existing program & data to answer these questions. Reallocate more resources to these critically important special studies.	We agree, and have proposed several studies to address these issues, see response to item 4 in the "General Review" table and the narrative response for details. In general, this will be a challenge given existing staffing, staff expertise, and work priorities.

Table C: 2002 IEP SAG Review of the EMP: Additional Comments by individual SAG members, cont.

SAG member	Recommendation	EMP response
Ed Houde *(numbered comments)*		
(1. & 12.) Program goals & action priorities	Documenting trends is a legitimate goal for the EMP, and prioritizing monitoring & special studies actions is a good thing	We appreciate the validation.
(2.) More special studies are good, but:…	…How will special studies be supported?	Some (smaller) studies will be supported through EMP budget reallocations. Others will compete for additional IEP & CALFED funding through research proposals. Unfortunately, IEP can currently not fund any new (2004) studies and we will thus submit proposals to CALFED.
(3., 6., & 7.) Consistency vs. procedural advances, and proposed methodological changes	Consistency is no excuse for continued use of inferior methods. Whenever new methods are introduced, cross calibrations & documentation thereof are essential!!! Ed agrees with proposed procedural changes.	We agree, and are working on (cross-)calibrations, better documentation, etc.
(4.) Zooplankton procedures	Written SOP.s & QA/QC	Yes, we need this (linked with data).
(5.) Zooplankton expansion into the Bay	Should be done	We recommend this. However, because of the mandated nature of the EMP, we recommend that this be done as part of the IEP Bay study and not as part of the EMP.
(8.) Larval fish sampling element.	Could be added at no extra sampling cost if proposed larger zooplankton net is used. Enumeration would add cost though.	This is a valid comment, but larval fish monitoring is outside the scope of the EMP. We recommend IEP management should consider establishing a larval fish monitoring program after IEP staff analyzes the existing historical data.
(9.) Jellyfish abundance & biomass	Interesting indicator of environmental stress & global coastal change. Might routinely use crude on-board abundance/biovolume index.	Yes, we agree, and will investigate implementation.
(10.) Zooplankton (& phyto., benthos) size spectra	Zooplankton sizes should be recorded.	DFG staff currently classifies zooplankton life stage based on size and morphology and records mysid length. Work on the data structure is needed. Phytoplankton unit size is recorded.
(11.) "Cross-cutting" application/program integration; "Integrative monitoring"	More is needed. Could lead to indices of biodiversity, relative dominance of exotics, trophic dominance, size structure, overlaps of taxa & WQ variables, etc.	This is a comment made by other SAG members as well. See our response to item 3 in the "General Review" table.
Alan Jassby **(on Aquatic Base Producer (ABP) SAT report)**		
Inconsistencies, omissions, & mistakes in report	Various specific corrections & additions to report…	Report will be corrected.
Web-accessible data	Is it necessary? Why not maintain an ftp site, hand out CDs?	The ftp site is probably a good idea. We hand out CDs upon request. The basic idea, however, is to get the data in a place that is readily available to the public to minimize the amount of time staff spent fulfilling data requests.
Reporting	Should include both explanation of ABP importance & reporting of trends & phenomena. Use QC charts for critical variables.	Right. We are using Chesapeake Bay web site (and a few others) as model. Will look into QC charts.
Station placement & data analysis	New analyses to find stations with similar magnitudes AND similar dynamic behavior for better grouping (or don't group).	We agree and are hoping for continued help from Alan Jassby (via his new CALFED study, etc.)
Continuous data	Needs to be brought into usable format	We agree. This is a task within the larger data base work underway. Work on this task has started.

Table C: 2002 IEP SAG Review of the EMP: Additional Comments by individual SAG members, cont.

SAG member	Recommendation	EMP response
Alan Jassby , cont.		
Discrepancies in optical data between EMP & USGS, and other optical matters	Need for well-defined investigations. K_d & TSS should be measured (but clearly state questions/goals). Continuous turbidity sensors need to be calibrated for TSS.	We agree.
C:Chl a ratios	What are reasonable values for the Delta? Should be investigated...	We agree, intend to do this using phytoplankton biovolumes once phytoplankton enumeration procedures have been confirmed
Yearly PPr incubations	Don't do them, variability is too high.	OK.
Phytoplankton enumeration & sampling procedures	Microscopic procedures need to be evaluated & revised to adhere to SM. Historical data set may be used for key species. Fewer composite samples (e.g. along transects) may be counted with improved methods.	Studies to determine the situation and recommend next steps are underway.
Phytoplankton blooms, SPM, & remote sensing	Remote sensing should be explored to detect phytoplankton blooms & SPM variability. Collaborators are readily available (e.g. NASA)	First proposal to IEP to explore remote sensing utility was rejected by the IEP Management Team, second proposal recommended for funding, but funding may not be available. We have identified a collaborator at UCSC. Also upcoming: a study to establish sampling methods for and extent of *Microcystis* blooms (Lehman et al.)
Comments related to specific tables in the review report	Various specific comments & corrections to these tables	The tables have been reconsidered and revised accordingly.
Alan Jassby (on Benthic Monitoring Element SAT report)		
How have Delta stations improved our understanding of the benthos?	It isn't clear from the overview how the Delta stations have improved our understanding of the benthos. Is this perception true? If so what are the barriers?	Your perception is largely correct. For example, the monitoring at EMP benthic stations has not allowed us to estimate regional or Delta-wide benthic grazing rates or gain a better understanding of what ecological processes the benthos substantially contribute to. However, beyond the elementary information you note, monitoring in the Delta has allowed us to track changes in community composition and the spread of introduced species (e.g., *Gammarus diberi*). All of the barriers mentioned apply (lack of analysis, difficulty in interpretation, and inadequate spatial coverage). This is not an easy fix. See our response 4. in Table B for the approach we recommend.
Time series analysis of grain size data.	Could time series analysis of grain size spectra give us an index of change for bottom sediment, perhaps shedding some light on long-term changes in TSS?	This is definitely worth exploring. Graphs showing long-term sediment composition show that most monitoring sites are quite stable in sediment composition with mainly seasonal, if any, variability. TSS in the Delta is probably more related to river inputs. TSS in the Bays is probably affected by both river inputs and wind resuspension.

Table C: 2002 IEP SAG Review of the EMP: Additional Comments by individual SAG members, cont.

SAG member	Recommendation	EMP response
Alan Jassby (on Benthic Monitoring Element SAT report, cont.)		
Spatial distribution and temporal resolution of sampling sites and determining appropriateness of current sampling scheme.	Is there evidence in the historical record that the existing spatial resolution is sufficient for Delta-wide averages? Can we find evidence that temporal resolution is sufficient to understand important event-related changes? Cross-channel variability is only a part of the more general small-scale sampling issue. Is it feasible to determine the variograms of abundance at different locations and times and use them to make some deductions about number and spacing of replicates? A rotating panel design that is adaptive with respect to water year type is a promising approach that needs to be investigated.	The historical record suggests the existing spatial resolution is not sufficient for delta-wide or within delta regional averages (see Markmann 1982 and Hymanson et al., 1994). There is evidence that the temporal resolution is sufficient to understand consequences of species introductions (e.g., *P. amurensis*) and droughts or floods (see Hymanson et al., 1994). Additional analyses in progress by Heather Peterson may provide additional insights, but past analyses suggests only major events are detectible with any confidence. Hymanson et al. (1994) conducted a sensitivity analysis and found that variability was very high within and among sites. The number of replicates now taken is really the minimum number necessary for calculating confidence limits and annual means. The conclusions about the number of replicates was that at least an order of magnitude more replicates is needed to substantially improve sampling sensitivity to change. The spacing of replicates has not been investigated beyond the left, right, center sampling conducted at some stations. EMP staff is currently investigating this issue further through historical data analyses and spatially intense sampling (May 2003). Alternative sampling designs (including a rotating panel design) will be investigated based on results from these and additional studies.
Compilation of diet information	There are many scattered pieces of information on diet. Is it time to begin gathering these data into some coherent database for the benthos, plankton, and neckton? Perhaps the BEET could take on the benthic part of this activity.	Yes this is true, and the BEET would be a great forum to take on the benthic part of this activity. A proposal to accomplish this task ("Benthos Bio Guide") has been submitted for 2004 IEP funding.
Alan Jassby (on Water quality Monitoring Element SAT report)		
Influence of tidal excursion	The diversity of physical settings and circulation patterns is certainly clear, but how big is the homogenizing influence of a 20-Km tidal excursion on water quality? This question might be addressed with the continuous horizontal measurements.	This is a good question and our best approach to address this question is probably to use the continuous horizontal data. We will do this once the horizontal data is in a useful form. Eventually, remote sensing may also provide useful data to answer this question for some variables.
Strategic moves: shifting emphasis from discrete to continuous monitoring and increasing the emphasis on remote sensing.	These may be the most important strategic moves of this revision. Shift as much resource as possible from discrete to continuous monitoring. Pursue the potential for using remote sensing.	We appreciate your endorsement of these strategic moves. While there is unanimous support for the shift from discrete to continuous monitoring, this situation does not exist for the pursuit of remote sensing. We are finding that there are divergent but definite opinions on the utility of remote sensing.
Discrete sampling on alternating spring-neap tides or sample the same tidal stage. Appropriate spatial distribution for sites.	The decision to sample on alternating spring-neap tides versus sampling the same tidal stage needs more consideration. For discrete sampling and horizontal transects, it seems optimal to center the sampling on the time when the rate of change of each WQ variable is the smallest. Just like sampling in time, optimal sampling in space depends on the goals. Different sampling regimes favor different aims and there is no right answer. More consideration is necessary to find some appropriate compromise.	The recommendation at this time is to try and sample at the same tidal stage but alternate between spring and neap tides. Historically, the program has emphasized sampling at the same tidal stage each month without regard to the spring-neap cycle. Sampling is not on a fixed monthly schedule. In addition to considerations of variability and bias there are also the practical considerations of boat speed, safety, and work schedules. However, your points are well taken and we have developed a more systematic/objective basis for determining the spatial distribution of sites as well as the sampling frequency, see narrative response.

Table C: 2002 IEP SAG Review of the EMP: Additional Comments by individual SAG members, cont.

SAG member	Recommendation	EMP response
Alan Jassby (on Water quality Monitoring Element SAT report, cont.)		
Continuity among sites/ representativeness of shore-based versus center channel continuous monitoring stations	Measures taken to ensure continuity between the two sites are extremely important. Maybe there should be some predetermined standards to assess how well continuity can be assumed.	We agree, it is very important to determine the relationship between measurements at the old and new locations if stations are moved. Presently, we plan to begin to first investigate this issue at the Martinez station. This investigation will be very intensive and should help to develop predetermined standards to assess continuity between stations.
Homogeneous versus heterogeneous regions of the Estuary	What about the photo showing the river is sometimes highly structured group of adjacent streams flowing past Rio Vista?	The famous photo is of the Yolo Bypass, not the Sacramento River. However, there is evidence (empirical data from W. Sobczak and modeling work by N. Monsen) that the Sacramento River is not homogeneous around Rio Vista. A detailed cross-sectional survey is needed at most (or all) shore-based monitoring stations (see also Table 5).
Comments about various measurements	Can Secchi disk depth be dropped in favor of a more sensitive measure such as PAR attenuation? Isn't TKN redundant given TON and NH4?	We have not considered dropping Secchi because there is no real savings in staff time/resources. There is likely some small amount of staff time saved through reduced data management. We will consider this further. We are recommending re-initiating measurements of light attenuation. J. Sharp provided extensive comments about TKN and suggested discontinuation of TKN, TDS, VSS, and DON, monitoring TDN and DOC instead. We are working with DWR water chemists to make decisions about this.
Mossdale Vs. Vernalis	Caution: Mossdale appears to behave uniquely, at least with respect to Chl trends.	We compared continuous records of DO, temperature, EC, and pH collected at Mossdale to discrete measures of the same constituents at Vernalis. The correlations were very high (see Water Quality SAT report). However, recent investigations by P. Lehman show chlorophyll concentrations change substantially in the stretch of river between Vernalis and Channel Point, suggesting that neither Mossdale nor Vernalis provide good estimates of the chlorophyll entering the Delta from the San Joaquin River. However, Vernalis has historical precedence and conceptually people are most comfortable with Vernalis as the station describing Delta boundary conditions for the main-stem San Joaquin River. Another program within DWR has received funding to establish a continuous monitoring station just down stream of Vernalis. We now propose to jointly operate this station and investigate discontinuation of the Mossdale station.
Comments on the summary and recommendations regarding water clarity	The understanding has improved somewhat over the description provided. The description of the recommendation seems vague and needs to be laid out better.	Some of the vagueness in the recommendation is intentional to leave some flexibility down the road. Your specific suggestions for changes would be appreciated.
Station issue	The Station coverage in the South Delta seems sparse. Nothing at Clifton Court?	The South Delta is particularly expensive to sample in because of the long travel times by boat or vehicle to get to sites. However, we now propose sampling of all EMP elements at Vernalis in collaboration with DWR-MWQI and at Clifton Court in collaboration with DWR O&M.