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May 15, 2014

To: Randy Fiorini, Chair
Delta Stewardship Council

Charlton Bonham, Director
California Department of Fish and Wildlife

From: Delta Independent Science Board

Subject: Review of the Draft EIR/EIS for the Bay Delta Conservation Plan

The Delta Reform Act of 2009 (§85320(c)) instructs the Delta Independent Science Board to review the Bay Delta Conservation Plan (BDCP) Draft Environmental Impact Report/Environmental Impact Statement (DEIR/DEIS) and to submit our comments to the Delta Stewardship Council and the California Department of Fish and Game. We have focused our review on the adequacy of the science and the validity of the conclusions drawn from that science. The accompanying document constitutes our legislatively mandated review.

We commend the preparers of the Draft BDCP documents for assembling and analyzing mountains of scientific information, and for exploring environmental impacts of many proposed BDCP actions. The preparers faced a bewildering array of regulatory requirements and economic, social, and political pressures.

We find, however, that the science in this BDCP effort falls short of what the project requires. We highlight our concerns in the attached report. The report, in turn, draws on our detailed responses to charge questions from the Delta Stewardship Council (Appendix A) and on our reviews of individual chapters in the DEIR/DEIS (Appendix B). Our concerns raise issues that, if not addressed, may undermine the contributions of BDCP to meeting the co-equal goals for the Delta.

cc:
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Review of the Draft BDCP EIR/EIS and Draft BDCP

Conducted by the

Delta Independent Science Board

May 15, 2014

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Summary of Major Concerns

Does the Bay Delta Conservation Plan (BDCP) Draft EIR/EIS (DEIR/DEIS) use the best available science in analyzing project alternatives and their effects? That is, do the analyses use science that is good enough, and use it well enough, for a project that is so large, complex, expensive, long-lasting, and important?

We find that the DEIR/DEIS currently falls short of meeting this "good enough" scientific standard. In particular:

1. Many of the impact assessments hinge on overly optimistic expectations about the feasibility, effectiveness, or timing of the proposed conservation actions, especially habitat restoration.
2. The project is encumbered by uncertainties that are considered inconsistently and incompletely; modeling has not been used effectively to bracket a range of uncertainties or to explore how uncertainties may propagate.
3. The potential effects of climate change and sea-level rise on the implementation and outcomes of BDCP actions are not adequately evaluated.
4. Insufficient attention is given to linkages and interactions among species, landscapes, and the proposed actions themselves.
5. The analyses largely neglect the influences of downstream effects on San Francisco Bay, levee failures, and environmental effects of increased water availability for agriculture and its environmental impacts in the San Joaquin Valley and downstream.
6. Details of how adaptive management will be implemented are left to a future management team without explicit prior consideration of (a) situations where adaptive management may be inappropriate or impossible to use, (b) contingency plans in case things do not work as planned, or (c) specific thresholds for action.
7. Available tools of risk assessment and decision support have not been used to assess the individual and combined risks associated with BDCP actions.
8. The presentation, despite clear writing and an abundance of information and analyses, makes it difficult to compare alternatives and evaluate the critical underlying assumptions.

This overview expands on these major concerns, suggests possible improvements, and states our concurrence with the major points of a recent review of the BDCP Effects Analysis. More detail and specifics are provided in two appendices. Appendix A contains our responses to specific charge questions from the Delta Stewardship Council. Appendix B evaluates most of the individual resource chapters in the DEIR/DEIS.

Review Process and Approach

The Delta Reform Act of 2009 (§85320(c)) instructs the Delta Independent Science Board to review the Bay Delta Conservation Plan (BDCP) Draft Environmental Impact Report/Environmental Impact Statement (DEIR/DEIS) and to submit its comments to the Delta Stewardship Council and the California Department of Fish and Game. To meet this responsibility, we conducted interviews, held briefings, and spent hundreds of hours reviewing the chapters and appendices of the DEIR/DEIS. Our review focuses on the science in the DEIR/DEIS: how well the statements and conclusions are supported by current scientific information; how science is applied to proposed actions; how completely actions and their potential consequences have been assessed; and how science is communicated. To understand the content of the DEIR/DEIS, we found it necessary to extend our review to include chapters and appendices in the Draft BDCP. We reviewed files posted on December 9, 2013, at http://baydeltaconservationplan.com/PublicReview.aspx. We also considered comments on a preliminary draft of our review provided by the Department of Water Resources[1], for which we thank the Department staff.

Our review focuses on identifying problems so that they can be addressed. We view the BDCP as a rare opportunity to coordinate scientific approaches and strategic decisions regarding infrastructure and human resources, together with environmental, regulatory, institutional, and financial aspects of Delta management—all in the context of improving water-supply reliability and ecosystem health in the Delta. Our review has been influenced by the recognition of the importance of this unique opportunity, and also by an awareness that the BDCP may not yet mesh as well as it could with the broad goals of the Delta Plan.

Some Strengths of the Draft BDCP and DEIR/DEIS

Although many of our comments in this review draw attention to areas in which we find the BDCP documentation or analyses inadequate or incomplete, it is important to recognize at the outset that the Draft BDCP and DEIR/DEIS represent a massive undertaking. An astounding amount of information is presented, accompanied by an impressive array of analyses of a comprehensive range of proposed actions and their potential effects. The efforts of the many contributors to the documents and the underlying foundation should be recognized and appreciated.

We mention here several areas in which the BDCP efforts are particularly noteworthy:

- Background descriptions of the Delta environment, the CEQA and NEPA context, and projections of climate change and sea-level rise, among others, are detailed yet clear.
- The presentation of alternative water-conveyance designs (CM1) is comprehensive and evenly balanced.
- Many of the resource chapters are extensive and comprehensive, presenting an overwhelming amount of information and detail, while focusing on some of the most critical potential impacts.

[1] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf.

- Where impacts are anticipated, appropriate Mitigation Measures or Avoidance and Minimization Measures are often described.
- Although the set of models used is limited, the ones that are used are employed effectively.
- There is frequent reference to the important role that adaptive management and monitoring will play in implementing the actions and evaluating their effects; there is a clear intention to make adaptive management a centerpiece of the project.
- There are in-depth evaluations of individual species, particularly the use of full life-cycle models for two of the salmon.
- Climate change and sea-level rise are not only mentioned, but are incorporated into some of the analyses.

Major Concerns

We found several broad areas in the DEIR/DEIS (including referenced parts of the Draft BDCP) to be scientifically incomplete or insufficient. Addressing these deficiencies will strengthen the prospects for improving water reliability and ecosystem health in the Delta through the BDCP and enhance its integration into the Delta Plan.

1. *Expectations for the effectiveness of conservation actions are too optimistic.*— Throughout the DEIR/DEIS, the BDCP actions, as supplemented by Avoidance and Minimization Measures and Mitigation Measures, are assumed to produce the anticipated benefits when they are needed to offset any impacts of BDCP actions. In essence, it is often argued that Conservation Measures (CM) 2–22 will have sufficient positive benefits for covered species to counterbalance any negative impacts of water diversions and changes in flow caused by proposed alternatives (CM1).This is an implausible standard of perfection for such a complex problem and plan, as noted in our reviews of Chapters 11 and 12 (Appendix B). It would be better to begin with more realistic expectations that include contingency or back-up plans.

2. *Uncertainties are inconsistently and incompletely addressed.*— Project conclusions or comparisons among alternatives or the impacts of the Conservation Measures are encumbered by unaddressed uncertainties. Uncertainties accompany every action and consequence discussed in the DEIR/DEIS, ranging from the designations of habitats for individual species, to projections of entrainment, to modeling results used in the analyses. When combined, these uncertainties will be compounded and propagate. Although the Draft BDCP discusses some of these uncertainties, they are treated inconsistently in the DEIR/DEIS and are largely ignored in the Executive Summary. These concerns are elaborated in Appendix A under the heading ‘Uncertainty,’ and related concerns about treatment of assumptions can be found there under ‘Sensitivity to assumptions, uncertainty, and conflicting data.’ If the outcomes of an action are considered too uncertain or speculative, it is sometimes argued in the documents that this uncertainty is sufficient reason not to address the issue of uncertainty at all. This approach is apparently based on a strict and narrow reading of NEPA and CEQA guidelines, which “require lead agencies to assess the potential for environmental effects based on the best available

information and tools and avoid speculation".[2] Avoiding clear articulation of uncertainties is not the same as avoiding speculation. By inadequately addressing uncertainties, the documents may fail to prepare those charged with implementing the Plan to deal with surprises. Unaddressed, uncertainties can pose major and significant risks to the project as a whole and lead to false expectations from managers and stakeholders. If uncertainties are acknowledged, however, expectations of the outcomes and benefits of BDCP actions will be more realistic, enabling a more reasoned assessment of how the actions align with NEPA and CEQA standards.

Although each of the BDCP actions is accompanied by uncertainties, perhaps the most important relate to how and to what extent the uncertain benefits of the actions detailed in Conservation Measures 2-22 will counterbalance the more certain impacts of Conservation Measure 1. It is important to recognize that Conservation Measures 2-22 are likely to have values in their own rights and are worth implementing regardless of which alternative (if any) is eventually selected. It seems reasonable to us that these measures will likely have positive effects on the ecological health and water quality of the Delta. Whether those positive effects will be adequate to offset the negative impacts of Conservation Measure 1, as assumed in the DEIR/DEIS, is uncertain, in part because they are given only program- rather than project-level analysis. As we state in the review of Chapter 11 (Appendix B), these measures are hypotheses to be tested, or perhaps broadly defined adaptive-management experiments. They need to be treated as such.

3. *The potential effects of climate change and sea-level rise are underestimated.*—Future climate change and sea-level rise are perhaps the greatest sources of uncertainty affecting BDCP. The Draft BDCP and DEIR/DEIS describe how climate change and sea-level rise might influence communities, species, and some aspects of hydrology, and how the BDCP actions may enhance resiliency and adaptation to these effects. However, the speed, magnitude, and intermittent nature of these changes may alter the outcomes of BDCP actions from what is planned. The potential direct effects of climate change and sea-level rise on the effectiveness of actions, including operations involving new water conveyance facilities, are not adequately considered. We focus on these concerns in our review of Chapter 29 and in a marsh-accretion sidebar in the Chapter 12 review (Appendix B). Similar comments could be made about the treatments of other disrupting factors, such as floods, levee failures, earthquakes, or invasive species, any of which could profoundly alter the desired outcomes of BDCP actions.

   In their response to our preliminary draft review, the Department of Water Resources noted that "the scope of an EIR/EIS is to consider the effects of the project on the environment, and not the environment on the project".[3] If the effects of major environmental disruptions such as climate change, sea-level rise, levee breaches, floods, and the like are not considered, however, one must assume that the actions will have the stated outcomes. We believe this is dangerously unrealistic. CEQA requires impacts to be assessed "in order to provide decision makers enough information to make a reasoned

[2] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf, comment #4 and others.
[3] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf.

choice about the project and its alternatives".[4] Surely this choice should also include consideration of factors that may substantially alter the outcomes of the project.

4. *Confounding effects of linkages and interactions among species, landscapes, and the proposed actions themselves are insufficiently considered.*—The DEIR/DEIS acknowledges that the Delta is a complex, interacting system. In such systems, actions in one place or for one species will affect dynamics, both there and elsewhere, of the same or other species. Consequently, failure to meet the expectations of BDCP actions will have cascading effects. If the competitive or predatory effects of one species on another or the effects of habitat restoration in one place on upstream or downstream restoration projects are not fully considered, the effectiveness of actions may be compromised. Although some non-covered species are combined for analysis and some predation effects are considered, much of the DEIR/DEIS is focused on individual species, particular places, or specific actions that are considered in isolation from other species, places, or actions. In particular, potential predator-prey interactions and competition between covered and non-covered fish species are not fully recognized. By failing to treat the Delta as a fully functioning and integrated ecosystem, however, interactions that may enhance or undermine the effectiveness of BDCP actions may be overlooked. The potential consequences of such interactions should be described and evaluated, even if only in a qualitative way. Our reviews of Chapters 11 and 12 (Appendix B) provide additional details.

5. *Several important effects are neglected*.—Although the DEIR/DEIS and Plan deal comprehensively with a multitude of potential impacts, we note several effects for which the treatment does not measure up to their importance. Appendix A gives examples under 'Impacts selected for thorough analysis.'

   First, the geographic scope of the DEIR/DEIS was defined to exclude San Pablo Bay and San Francisco Bay. The consequences of BDCP actions undertaken within the Plan Area, however, will extend downstream to affect these bays. Changes in sedimentation in the Delta associated with BDCP actions, for example, will not be confined to the Delta. Likewise, changes within the bays (e.g., tidal wetland restorations) will affect tidal fluxes and salinity intrusion into the Delta. Many fish species also migrate into or through these areas.

   Second, although levees receive considerable attention in both documents (as befits their importance to what goes on in the Delta), the coverage is disconnected and incomplete. In particular, neither the consequences of levee failures on the effectiveness of BDCP actions nor the financial implications of demands for levee maintenance receives adequate attention. The assumption that most levee breaches will be repaired seems unrealistic.

   Third, the increased water reliability produced by BDCP (if successful) will particularly benefit the agricultural sector, and these economic benefits receive quantitative attention

[4] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf, comment #17.

in the Plan and DEIR/DEIS. However, there is no parallel discussion of possible environmental impacts that might arise as increased reliability affects which crops are planted, how fertilizers and pesticides are used, or how these changes might affect agricultural runoff and water quality.

All three of these examples reflect decisions about how to set boundaries for the BDCP impacts and analyses. San Pablo and San Francisco bays are not considered because they fall outside of the legal boundaries of the Delta. For both levee failures and the environmental impacts of increased water reliability for agriculture, the argument is made that the potential impacts are too speculative to be included in the analyses, so uncertainty (at some undefined level) has determined a boundary on what is or is not considered. We do not believe that the processes used to determine these boundaries have been made explicit, nor are the boundaries scientifically justified. We know that there is a high likelihood of future levee breaches and that farmers will adjust their crops and management in response to changing water availability. Although we may not be able to anticipate these changes in detail, to ignore them is to pretend that they won't happen. Sufficient information exists to construct and evaluate future scenarios. These potential effects merit more careful consideration.

6. *The adaptive management process is not fully developed.*—In keeping with its importance, adaptive management receives comprehensive discussion as the third and longest section in our response to the Delta Stewardship Council's charge questions (Appendix A). Adaptive management is the key to dealing with uncertainties and successfully implementing BDCP. The proposed organizational infrastructure to support adaptive management is well described in the Plan. Yet, although adaptive management is mentioned frequently in the DEIR/DEIS, details about how it will be designed and done are left to a future Adaptive Management Team. As a result, it is unclear how adaptive management will be integrated into the implementation of BDCP, whether the scientific skills needed to plan and oversee adaptive management will exist in the Implementation Office and on the Adaptive Management Team, and whether the capacity to conduct the monitoring and analysis needed for adaptive management will be available. Because conditions in the Delta and responses to BDCP actions may change quickly, the adaptive-management process must be nimble and flexible, yet the organizational structure may delay rather than expedite needed adjustments. Although the Draft BDCP has an extensive listing of performance measures linked to its Biological Goals and Objectives, the measures needed to evaluate actions and make adjustments are not addressed substantively in the DEIR/DEIS. Neither are there any indications of the criteria that might be used to establish "trigger points" at which adaptive management procedures would be initiated. This becomes particularly problematic if certain species are benefitting from actions and others are doing worse.

   Because BDCP actions will not likely play out as planned, it may be useful to view them as planned experiments or hypotheses to be tested. Consequently, it would be prudent to have contingency plans generally outlined *before* discovering that actions are not working as expected. Yet contingency plans are rarely mentioned in the documents we reviewed. We are not yet convinced that the process of actually doing adaptive

management (rather than creating an organizational infrastructure for it) has received the thoughtful development it requires, given its central role in implementing BDCP and ensuring that impacts and benefits balance. Consequently, we have substantial misgivings about how well the proposed adaptive management process, as proposed, will actually function as a key component of BDCP.

7. *Risks are not modeled or fully evaluated*.— There are risks with almost every action proposed as part of BDCP. These risks can interact and cascade, with potentially major consequences. Risk assessment and decision theory can be used to assign probabilities, uncertainties, and magnitudes to various risks. Such tools could help evaluate which aspects of BDCP are most vulnerable to high-consequence risks and aid in preparing contingency plans. We found no indications that the available scientific approaches to risk assessment were used to any great extent in the development of BDCP. Given the concerns over uncertainty and the proposed adaptive-management plan, it would be worthwhile to consider incorporating structured decision-making into the process. We provide some useful references in Appendix A in the section 'Tools for decision making.'

8. *Descriptions of the alternative conveyance structures, operations, and environmental impacts do not facilitate informative comparisons*.—A central purpose of an EIR/EIS is to clearly describe the alternative options—in this case, water-conveyance operations—and their relative impacts. In the DEIR/DEIS, each alternative is examined separately in great detail, in a consistent manner. However, because no overall framework is provided to draw together the specifics of the alternatives in a clear way, it is difficult to compare alternatives. Consequently, it is challenging to develop a rigorous assessment of the relative strengths and weaknesses of the alternatives, as we discuss in the section labeled 'Clarity' in Appendix A. Moreover, each alternative is influenced by the areas of concern we have noted above. Treating all alternatives in exactly the same way ignores the reality that these factors affect the alternatives and conclusions about their impacts in different ways, further confounding comparisons.

Relation to the Findings of the BDCP Effects Analysis Panel Review

In March 2014 the Delta Science Program released the final report of Phase 3 of an Independent Panel's review of Chapter 5 (Effects Analysis) of the Draft BDCP, dealing with the analysis of potential ecosystem effects of BDCP actions. This review was released after we had completed an interim draft of our findings. The Independent Panel's review was narrower and deeper than ours, dealing with a single (lengthy) chapter rather than the entire DEIR/DEIS and relevant parts of the Draft BDCP documents.

We have reviewed the report of the Independent Review Panel and concur with their findings. Here, we note several important areas of agreement in the reviews. In particular, the reviewed documents:

- Do not adequately convey the sources and effects of uncertainties. Although significant uncertainties were included in technical appendices of the Draft BDCP, they were not

adequately addressed in Chapter 5. In particular, the critical uncertainties associated with the presumed beneficial effects of tidal wetland restoration were not addressed;

- Do not include clear statements of critical assumptions underlying many of the proposed actions and their consequences;
- Characterize adaptive management as the default solution to unresolved issues and uncertainties, without a clear description of how adaptive management will actually be implemented or how it is tied to monitoring;
- Fail to recognize that habitat restoration is a lengthy process with uncertain results and timing;
- Present modeling results without thorough sensitivity analyses or consideration of a range of possible scenarios;
- Partition the Delta into separate pieces (e.g., covered species) without also considering linkages and the broader spatial and temporal dynamics of the Delta as a system;
- Use a flawed analysis to determine net effects. Although a semi-quantitative approach is used initially, the final analysis uses professional judgment to assess net effects. As such, it is a "working hypothesis," although this is not acknowledged throughout the document; and
- Present a massive amount of detailed information in a poorly organized and synthesized fashion with no clear and concise summaries, making it difficult to evaluate and compare the consequences of proposed BDCP implementation alternatives.

Improvements in the Scientific Framework of BDCP

We recognize that many people have put a tremendous effort into preparing the Draft BDCP and DEIR/DEIS, which contain a wealth of detail and many useful analyses of potential actions. Nonetheless, the documents, and the eventual implementation of BDCP (if approved) would benefit from a careful consideration of the major points made above and in the more detailed treatments in Appendices A and B. Here, we offer several specific suggestions for improving science-related treatments; we follow with suggestions for improving the presentation of information in the DEIR/DEIS.

1. *Develop adaptive institutional, regulatory, scientific, human resource, and financial capacities*.—The ability to adapt implementation to changing conditions is the most important need for BDCP. It is implausible to expect that the Delta's future will occur exactly as assumed in any DEIR/DEIS analyses. Without the institutional, regulatory, legal, scientific, human resource, and financial capacities to adapt, BDCP will be unable to achieve its stated objectives. Broadly collaborative yet decisive governance is essential. While it may be premature to establish a framework for collaboration before BDCP is underway, it is not too early to begin planning. At this time, there is little in the Draft BDCP or the DEIR/DEIS to suggest how the many individual agencies, each with narrow responsibilities and its own mandates and agendas, will be integrated to conduct the effective research, integrative monitoring, modeling, and adaptive management needed to implement BDCP. Experience with the Interagency Ecological Program (IEP), however, shows it can be done.

2. *Integrate BDCP science with the Delta Science Plan.*— The science for BDCP must be clearly linked to the many related scientific problems of managing the Delta, and this scientific capability must be widely perceived as being independent and transparent. Science that is fragmented and partitioned among entities and interests is open to advocacy, which is unlikely to improve conditions in the Delta and will ultimately work against long-term adaptation and the interests of the state and stakeholders. Most of the major science activities must be broadly collaborative. If Delta management is to be guided by science, then science will need to be integrated and effectively communicated. The "One Delta, One Science" foundation of the Delta Science Plan provides a detailed roadmap for achieving this integration. Care should be taken to ensure that the organization and implementation of research, data management, modeling, and monitoring as parts of BDCP are closely meshed with the Delta Science Plan.

3. *Initiate pilot restoration actions as soon as possible*.— Pilot restoration actions (and other projects to address critical uncertainties) should be initiated as soon as possible, within a scientific framework that will allow BDCP and others to test, refine, and improve the effectiveness of restoration. Some studies that are already underway can be incorporated into BDCP once (or if) it is permitted; other studies being planned could benefit by addressing needs identified in the Draft BDCP or DEIR/DEIS. Current and planned habitat restoration projects in the Delta should be aligned as much as possible with the priorities identified in BDCP and the Delta Plan. This approach can reduce uncertainty and costs over the duration of the project and advance the early application of adaptive management.

4. *Use risk-based decision analysis to gain useful insights*.— A risk-based decision analysis of alternatives that includes some major contingencies would provide a more rigorous basis for structuring the document and developing a preferred alternative(s) for BDCP. A risk-based decision framework could be used to explore how potential adjustments in, for example, the size and placement of habitat restorations or the capacity of the Delta conveyance facility might reflect opportunities or problems likely to arise in the future. Such analyses could explicitly incorporate uncertainty into the comparisons of alternatives, while assessing other decisions about BDCP actions. Several tools are available (see Appendix A); although these may not be perfectly suited to issues in the Delta, they do provide helpful ways of evaluating relative risks.

5. *Learn from the current drought.*—The current California drought presents a powerful example of the need for federal, state, and local agencies and stakeholders to collaborate in managing a complex and changing problem in the face of multiple objectives and stresses. In other words, adaptive management. There will be lessons about challenges and solutions; these lessons should be incorporated into the further development of the adaptive management process and organization in BDCP.

Improvements in the BDCP DEIR/DEIS Document to Enhance Understanding

An EIR/EIS is a major document intended to inform policy-makers and the public about the beneficial and detrimental consequences of alternative project actions, including a reasonable no-action alternative. The DEIR/DEIS provides an exhausting wealth of information about the Delta and the likely impacts of the proposed alternatives. However, this wealth of information and data is not organized in a way that can usefully inform difficult public and policy discussions. Some improvements for the final document are suggested below; additional details for individual chapters appear in Appendix B.

1. *Include meaningful summaries for each chapter.*— Each chapter should begin with a sharply focused summary of the main points, conclusions, and important unresolved issues and uncertainties. We specifically note that the "Highlights" document does not do this and cannot be thought of as a substitute for a scientific summary.

2. *Provide a clear and concise comparison of water-conveyance alternatives.*— The DEIR/DEIS is intended to guide the selection of alternatives based on performance and consequences. The Executive Summary should focus on guiding the reader through a concise presentation of the alternatives, describing the process of selecting a preferred alternative, and evaluating the relative impacts of alternatives on major Plan objectives and operations and on the physical, biological, sociological, and economic resources of the Delta.

3. *Clarify performance indicators.*— Inclusion of clearly defined performance indicators for BDCP actions and trigger points for adaptive management action in both the chapter texts and the Executive Summary would help to focus a discussion and comparison of alternatives and would greatly improve the usefulness of the document. Without understanding how performance will be assessed, it will be difficult to determine what qualifies as "success" (or "failure").

4. *Incorporate uncertainties into conclusions.*— Presentation and discussion of the results of major analyses should include some indication of the uncertainty of those results. For quantitative and model-based analyses, this could include likely upper and lower bounds as well as an average or central tendency. For other analyses, a qualitative assessment of relative uncertainty or confidence in the results would be useful. A discussion of the implications of these uncertainties on any conclusions or comparisons and possible actions to reduce uncertainty is necessary for managing expectations and building trust.

5. *Bolster and consolidate the support framework for adaptive management.*— As currently described (only in the Plan; there is no description in the DEIR/DEIS), the adaptive management process will be difficult to implement in terms of financial and scientific support, institutional authority, or regulatory flexibility. It is critical that the management, regulation, and science supporting adaptive management for BDCP be integrated within a larger framework for adaptive management for the Delta. The DEIR/DEIS would benefit from a concise discussion of how the approaches to adaptive

management described in the Draft BDCP, the Delta Plan, and the Delta Science Plan could be blended into an effective and comprehensible framework.

6. *Identify and list important assumptions in each chapter*— Although many assumptions may be covered in appendices, the most important assumptions and their implications should be specifically listed and discussed in the main chapter texts, especially where the results of analyses are presented. This is done in some instances, but the treatment of assumptions is inconsistent. The most critical assumptions should be highlighted, perhaps in chapter summaries.

7. *Consider appropriate time frames for permitting BDCP actions*.— There are many uncertainties in BDCP actions, their consequences, and the use of adaptive management to adjust practices when necessary. Consequently, it would be appropriate for permits to include explicit intermediate milestones and opportunities for interim evaluation and correction within the 50-year time period of BDCP.

8. *Spell out the details of programmatic Conservation Measures*.—Currently, CM1 (water conveyance alternatives) is treated at a project level in the DEIR/DEIS, whereas the other Conservation Measures are dealt with at a less detailed program level. Additional detail should be provided, specifying ranges of possibilities or approximate actions wherever possible. This will enhance evaluations of the effectiveness and consequences of the Conservation Measures and the ability of benefits in program-level measures (CM2-CM22) to counterbalance any negative effects of the project-level CM1.

APPENDIX A

Responses of the Delta Independent Science Board to charge questions provided by the Delta Stewardship Council

SUMMARY

This appendix addresses four groups of questions that were provided by Delta Stewardship Council staff to help us, the Delta Independent Science Board, frame our legislatively mandated review of the DEIR/DEIS of the Draft Bay Delta Conservation Plan (BDCP). The summary on this page reproduces, in italics, the headings under which the Council staff grouped the charge questions. Our responses include comments on related sections of the Draft BDCP.

Overall, we found extensive description and analysis of the proposed conveyance facilities and operations and of the associated habitat Conservation Measures. Our responses focus on causes for concern about the effectiveness of the proposed Conservation Measures.

Completeness, structure, and effectiveness of presentation—The analyses vary in the rigor of the science employed. They appear incomplete in deferring detailed assessment of habitat restoration; in mostly neglecting Delta levees, San Francisco Bay, and effects of fertilizers and pesticides in water-service areas; and in not applying formal tools of risk-based decision making. The presentation is short on analytical summaries that readers will need to make informed comparisons among the various alternatives. Such summaries are needed further for synthesis of findings that are presented repetitively or are scattered widely. Notably lacking are graphics that provide data-rich synthesis at a glance.

Approach, analysis, tools and modeling—Few of the many uncertainties in DEIR/DEIS are acknowledged in conclusions about impacts and mitigation actions. Assumptions are rarely listed fully and conspicuously.

Monitoring and adaptive management—The reviewed documents posit adaptive management of an uncertain future without examining plausible outcomes. The Draft BDCP presents adaptive management more as a notion than as a tested, problematic practice. We found no evaluation of adaptive management's prior use in the region or in analogous settings elsewhere, nor much consideration of the potentially confounding or constraining effects of biotic, abiotic, and societal factors or conflicting trends between species. The strategy presented hinges on trust in an Adaptive Management Team and in uncertain funding.

Statutory questions—In the Delta Reform Act of 2009, conditions for incorporating the BDCP into the Delta Plan include "comprehensive review and analysis" of effects related to freshwater flows, climate change, fish and aquatic resources, and water quality. Difficulties for the DEIR/DEIS in these areas include oversimplified modeling of water supply, neglect of ecosystem perspectives in impact assessments for fish and aquatic resources, reliance on hypothetical ecological benefits from restored tidal wetlands in assessment of those impacts, uncertain effects of climate change and sea-level rise on the proposed Conservation Measures, use of non-comparable data from different water-quality monitoring programs, and use of water-quality guidelines that may provide insufficient protection to ecosystems.

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REVIEW PROCESS AND SCOPE

California law directs the Delta Independent Science Board to review the DEIR/DEIS of the Bay Delta Conservation Plan (BDCP). The directive states simply, "The Delta Independent Science Board shall review the draft environmental impact report and submit its comments to the council and the Department of Fish and Game" (Sacramento - San Joaquin Delta Reform Act of 2009, §85320(c)).

Staff of the Delta Stewardship Council helped us define the scope of this mandated review by providing specific charge questions[1]. The Council staff arranged the questions under four headings:

- Completeness, structure, and effectiveness of presentation
- Approach, analysis, tools and modeling
- Monitoring and adaptive management
- Statutory questions

Our responses are grouped under these same four headings and address each of the questions in turn. Each question can be found quoted in full, in italics, beneath each of the headings below.

Most of the charge questions refer chiefly to material in the DEIR/DEIS. Some of our responses refer the reader to details in individual DEIR/DEIS chapter reviews, which can be found in Appendix B.

For some charge questions we also drew on material in the Draft BDCP itself. This is particularly the case for the questions on monitoring and adaptive management.[2].

The "Statutory questions" refer to §85320(b) of the Delta Reform Act. This section states conditions for incorporating the BDCP into the Delta Plan. Those conditions include "comprehensive review and analysis" of several of the topics considered in our comments below.

BDCP staff provided initial responses, dated March 7, 2014, to many of the points raised in a preliminary version of this appendix, on lines 24-52 of a "BDCP and EIR/EIS Review Document Comment Form"[3]. We refer to them as the Initial BDCP Responses.

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[1] http://deltacouncil.ca.gov/sites/default/files/documents/files/Item_6_Attach_1_7.pdf

[2] The section below on monitoring and adaptive management, beginning on page A-10, was written largely by Michael C. Healey, Professor Emeritus of Biological Oceanography at University of British Columbia, Lead Scientist of the Calfed Bay Delta Program in 2007-2008, and member of the Delta Independent Science Board in 2010-2012.

[3] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf

COMPLETENESS, STRUCTURE, AND EFFECTIVENESS OF PRESENTATION

Articulation of objectives and purpose

1. Are the project objectives and purpose clearly articulated, to enable the identification of a reasonable range of alternatives?

DEIR/DEIS Chapter 2 clearly articulates overall objectives and relates them to challenges to meeting the coequal goals. The statements of purpose address CEQA and NEPA requirements. Subsequent sections discuss ecosystems, water supply, and water quality. Supporting documents include primers on the Delta and water exported from it (Appendix 1A), potential risks from earthquakes and climate change (Appendix 3E), expected consequences of reducing exports to areas south of the Delta (Appendix 5B), and background on how the alternatives were developed (Plan, Appendix 3A).

Chapter 2 could frame water supplies more broadly to help show whether the range of alternative actions is "reasonable." For example, water exports from the Delta could be described as part of a portfolio of actions that include water conservation, reoperation, water markets, alternative conveyance, wastewater reuse, water storage, desalination, and regional self-sufficiency. Citation could be made to the Delta Plan (2013), the California Water Action Plan (2013), and "Scarcity: the challenges of water and environmental management in the Delta and beyond," in National Research Council (2012, p. 29-46), as well as the "portfolio-based proposal" in DEIR/DEIS Appendix 3.11.1.1.

Definition of alternatives

2. Are the alternatives clearly defined?

DEIR/DEIS Chapter 3 contains detailed descriptions of action alternatives, and the meaning of "no action" is clarified by information in Appendix 3D, "Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions." The "Highlights of the EIR/EIS brochure"[4] offers a generalized guide to the action alternatives.

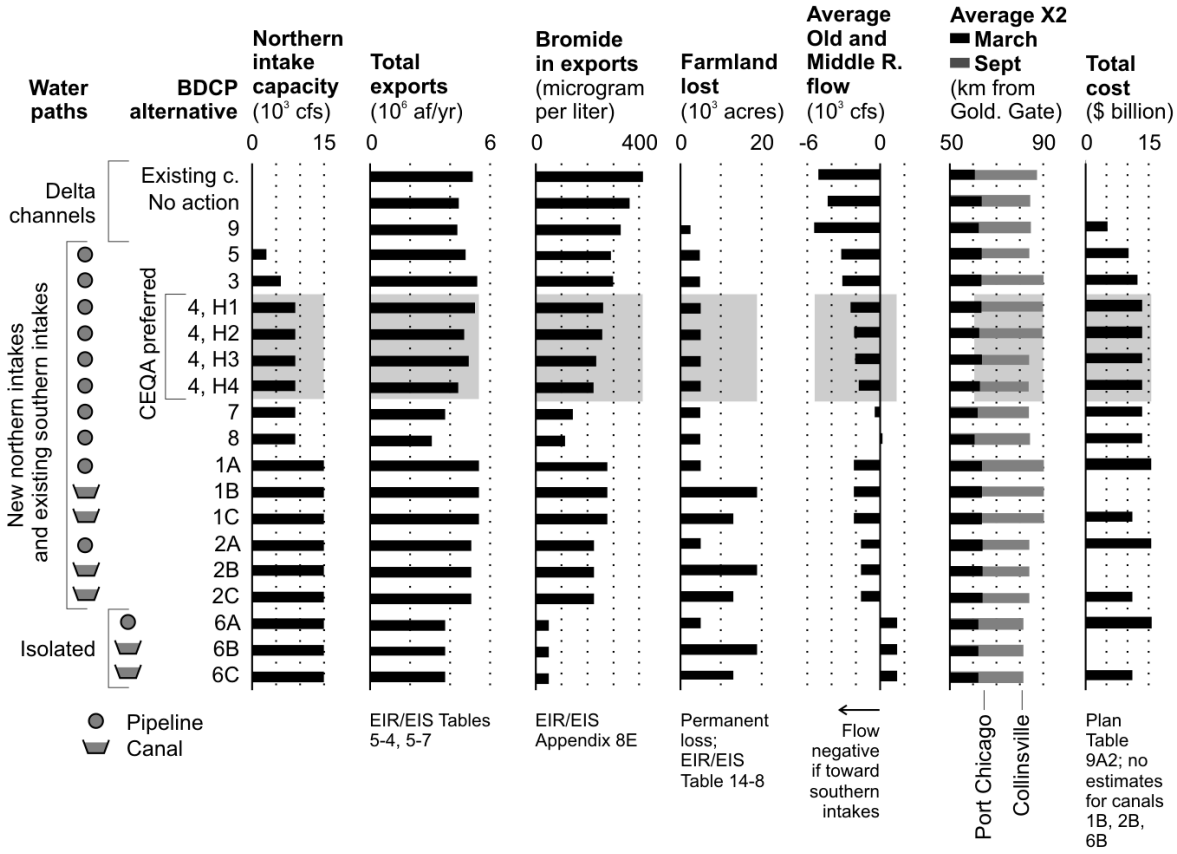
The DEIR/DEIS could identify the preferred CEQA alternative more clearly in several respects:

- How strongly preferred is Alternative 4 if the eventual project is not required to resemble it (Chapter 3, p. 3-4; Highlights Brochure sidebar, p. 7)?
- "As of this EIR/EIS, the federal Lead Agencies have not identified a Preferred Alternative for the purposes of NEPA" (p. 3-3). Please explain fully.
- The reasoning that led to the preference for Alternative 4 could be brought forward from Chapter 31. Section 31.3 is far more informative than are its more prominently placed alternatives: a brief explanation in Chapter 3 (p. 3-3), a summary of an announcement by state and federal officials (p. ES-22), and descriptions that emphasize the screening process developed and used (DEIR/DEIS Chapter 3 and Appendix 3A; Plan Appendix 3A and Chapter 9).

[4] Highlights+of+the+Draft+EIR-EIS+12-9-13.pdf, available at http://baydeltaconservationplan.com/PublicReview/PublicReviewDraftEIR-EIS.aspx

- The DEIR/DEIS blurs the most distinctive element of Alternative 4: the decision tree with four operational branches of Scenario H. The decisions are to be governed by research, but no plans for this research are presented (See Chapter 3 comments in Appendix B). In its description of alternatives, Chapter 3 defers first mention of any of the four operation plans by name until a footnote on page 3-67, and a table on page 3-208 defines them in obscure shorthand. The Highlights Brochure cites H1, H2, H3, and H4 (p. 20) but does so without defining them (p. 10).

The DEIR/DEIS needs focused summaries of the expected performance of alternatives. For readers keen on details, the report could provide comprehensive spreadsheets. All readers, especially decision-makers and the broader public, need graphics that provide informative summaries at a glance, and which are linked to detailed tabular comparisons, as in this diagram:



Range of alternatives

3. From a scientific perspective, does the EIR evaluate a reasonable range of potentially feasible alternatives that would reduce or eliminate significant impacts of the project and obtain most of the basic project objectives and purpose? If potentially feasible alternatives are not fully evaluated, is a clear rationale provided as to why not? Are there potentially feasible alternatives that would reduce or eliminate significant impacts of the project and obtain most of the basic project objectives that should have been considered (and either rejected or fully evaluated) but were not?

Please see the comment above on reducing California's reliance on water from the Delta and its tributaries (p. 4).

Detail of analyses

4. Are the alternatives studied in adequate detail to differentiate outcomes among the alternatives?

Overall, the DEIR/DEIS offers a level of detail that overwhelms more than it discerns. Much of this detail is unavoidable, given the large matrix of alternatives and impacts, the complexity of many of the scientific issues, and the associated uncertainties. The solution requires greater clarity in presentation (p. 7).

We extended the charge question on differentiating outcomes to include whether the analyses are thorough. We found the analyses less than thorough in three respects: they treat water-conveyance facilities more specifically than habitat restoration; they mostly neglect impacts on San Francisco Bay, Delta levees, and south-of-Delta agriculture; and they make little if any use of risk-based decision analysis.

<u>Program vs. project</u>

The DEIR/DEIS makes clear that concurrent actions receive different levels of analysis (p. ES-4 to ES-5; 1-13 to 1-14; 4-2). The concurrent actions include construction of new north Delta diversion and conveyance facilities (Conservation Measure 1) and "near-term" acquisition and restoration of natural communities (Conservation Measures 3-10) (DEIR/DEIS, p. 3-21; Draft BDCP, p. 6-3). Conservation Measure 1 receives both program-level and project-level assessment, whereas the other actions only receive program-level assessment, which is less rigorous by definition.

The DEIR/DEIS offers several explanations for the different levels of analysis: the BDCP is to be managed adaptively; few sites of ecosystem restoration have been selected; restoration is still “at a conceptual level” of design; and project-level analysis of habitat restoration is to be carried out as the restoration efforts progress (DEIR/DEIS p. 4-2). Still, the effects of recent marsh restorations in the Delta and Suisun Marsh could help test the benefits of habitat restoration that the DEIR/DEIS assumes in concluding that a net impact is beneficial under NEPA or a less than significant under CEQA (e.g., Chapter 11, p. 3023).

<u>Impacts selected for thorough analysis</u>

The impacts selected for analyses are described as "the direct and reasonably foreseeable indirect impacts associated with implementation of the BDCP alternatives" (Chapter 4, p. 4-10). However, the actual selections disregard:

Effects of altered Delta outflows on San Pablo Bay and San Francisco Bay. DEIR/DEIS section 4.2.1.2 dismisses impacts to San Francisco Bay with hardly any justification, as noted in our comments on Chapter 4 (Appendix B). The Initial BDCP Responses, in row 3, include the beginnings of what could be a helpful discussion of this basic question, one that many are sure to ask. Row 3 does not consider the likely impacts of altered sediment delivery, however.

Effects of and on levees. Although the DEIR/DEIS cites the threat of levee failures as a justification for new pipelines or canals, the reviewed documents offer no detailed analysis of how levee failures could affect the various alternatives, or of how the alternatives may affect the economics of levee maintenance. We found no part of the DEIR/DEIS, or of the Draft BDCP,

that relates Delta levees to the BDCP in more than a piecemeal fashion. We discuss these concerns in our review of Chapter 9 (Appendix B).

It can be argued that CEQA guidelines do not identify levees as resources; that BDCP is not a flood-control project; and that levee failure is too speculative for analysis. However, few Delta facilities are more important to its current functions than are its levees, and levee failure has happened too often (and the threat of future failures is invoked too much) to be excluded from thorough analysis in the DEIR/DEIS.

Effects on agriculture. We found little or no discussion of how increased reliability of water exports will affect applications of fertilizer and pesticides, salt accumulation in the San Joaquin and Tulare basins, and water quality of agricultural runoff in the service areas of the Central Valley Project and the State Water Project. The Initial BDCP Responses pointed us to DEIR/DEIS Chapter 30, sections 30.3.2.4 and 30.3.4.1, which do not appear to extend into environmental effects. As with levee failure, the plausible impacts of these effects go beyond mere speculation. Enough is known to bracket and assess a range of possible outcomes.

Tools for decision making

A risk-based decision analysis of alternatives that includes major contingencies would provide a more rigorous basis for structuring the document and refining a preferred alternative, or multiple preferred alternatives, for the BDCP. A risk-based decision framework could be used to explore future opportunities or problems that might arise from potential adjustments in, for example, the size and placement of habitat restorations or the capacity of the Delta conveyance facility. Such analyses could explicitly incorporate uncertainty into the comparisons of alternatives, while assessing other decisions about BDCP actions. The analyses could help allay concerns about overall uncertainty and about the proposed plans for adaptive management. Precedents can be found in Colorado River management and other complex adaptive management programs.

A response to this concern confirms that "there has been limited use of formal risk assessment and decision support tools in BDCP" (Initial BDCP Responses, row 7, page 8)[5]. The response concludes with a request for "specific suggestions about tools that may be available." Relevant reports include Allen et al. (2011), Burgman (2005), Gartner et al. (2008), Harwell et al. (2010), Lund et al. (2008), Lyons et al. (2008), Martin et al. (2009), Regan et al. (2005), Runge et al. (2011), Suddeth et al. (2010), and Thompson et al. (2013).

Assessed impacts and their comparisons

5. Overall are the analyses reasonable and scientifically defensible? How clearly are the roll-up comparisons among alternatives conveyed in the text, figures and tables?

Reasonableness and scientific defensibility

Please see the section below, headed "Best available science" (p. 12).

Clarity

Overall accessibility to the public and decision-makers. The immensity of the DEIR/DEIS impedes thoughtful comparison of its findings about the impacts of the no-action and action alternatives. Much of the draft contains excellent writing, understandable analysis,

[5] http://deltacouncil.ca.gov/sites/default/files/documents/files/ISB-Comment-Form-040114-final.pdf

and cross-references among its various parts. Nevertheless, the draft suffers from a paucity of analytical summaries, synthesis graphics (e.g., p. 5 above), lists of assumptions, and navigational aids that would enable readers to make strategic, well-informed decisions about the alternatives presented. Federal law provides grounds for expecting such clarity in an impact assessment: "Environmental impact statements shall be written...so that decision-makers and the public can readily understand them" (Council on Environmental Quality §1502.8).

It might be argued that, given its length and complexity, there simply was not enough time for the draft to be made readily understandable. This sounds penny wise and pound foolish. Our calls for greater clarity began in June 2012[6] and continued in comments on the 2013 Administrative EIR/EIS[7].

The available summaries include a table of impacts in the Executive Summary (Table ES-9) and chapter synopses in the DEIR/DEIS Highlights Brochure (footnote, p. A-4). These summaries, while welcome, fall short of making the draft understandable and lack qualifying statements. The rather cryptic table of impacts (Table ES-9) notably lacks caveats about differing degrees of uncertainty. Most of the chapter synopses in the Highlights document offer more background than analysis.

Justification for the preferred alternative. The DEIR/DEIS summarizes its case for the preferred CEQA alternative but buries this summary in section 31.3. A readily understandable report would contain an up-front, well-illustrated summary that lays out the main arguments for (and against) the preferred alternative by comparing it against other options—the no-action alternative, the through-Delta channel corridors, the east and west canals, an isolated tunnel, and dual tunnels of various capacities.

The comparison needs to include visual aids that help the reader visualize the main expected consequences of the various alternatives and relate these consequences to the co-equal goals. The prototype on page 5 illustrates how graphics can compare alternatives more efficiently and quantitatively than do text and tables alone. This kind of diagram should also represent expected major effects on ecosystems and species, and should express uncertainties in the plotted estimates.

Chapter summaries. Useful chapter summaries in the DEIR/DEIS are limited largely to its longest chapters (11 and 12). The Executive Summary provides an overview comparison among alternatives (section ES-9). The Executive Summary also provides a lengthy tabular summary of impacts, but the table is cryptic and graphics are lacking (p. ES-61 to ES-132). The DEIR/DEIS Highlights Brochure summarizes chapters unevenly, in most cases with more emphasis on description than on analysis. The Draft BDCP's prodigious Effects Analysis lacks a summary that goes beyond describing the chapter's contents (Draft BDCP section 5.1).

The DEIR/DEIS thus offers few of the summaries needed by decision-makers or by the public at large. The summaries should approach, in level of detail, the sections that begin the climate appendices to the Effects Analysis (Draft BDCP part 5A). The summaries would also proceed not just impact by impact, as done well in the chapter on Terrestrial Biological

[6] http://deltacouncil.ca.gov/sites/default/files/documents/files/DISB_Letter_to_JMeral_and_DHoffman-Floerke_061212.pdf

[7] http://deltacouncil.ca.gov/sites/default/files/documents/files/DSC_Letter_on_BDCP_Review.pdf, p. 10-11

Resources (p. 12-5 to 12-31), but by alternatives (for instance, no-action vs. actions, and certain kinds of actions vs. other kinds of actions).

The BDCP documents should incorporate the best available features of scientific communications. Nearly every scientific journal requires articles to begin with a well-written summary or abstract that lays out the main findings and their broader implications. For example, each abstract at the annual workshop of the Interagency Ecological Program includes a "Statement of Relevance" that puts the science in context.

Navigational aids. The DEIR/DEIS includes related parts of the Draft BDCP. This extension is footnoted on front matter of the DEIR/DEIS (p. ES-3, 1-2, and 3-3) and is clarified by cross-references to the Draft BDCP. However, the section "EIR/EIS Organization" (p. 1-31 to 1-35) describes the DEIR/DEIS as being self-contained, as does the DEIR/DEIS Highlights Document (on its p. 5 and 6), and the helpful 145-page index posted in December 2013 covers the DEIR/DEIS only.

The DEIR/DEIS scarcely mentions the public health and ecological problems associated with potential toxicity from the blue-green alga *Microcystis*. The reader must go to the Draft BDCP to find details about *Microcystis* toxicity and discussion of most of its potential environmental effects (Appendix B, review of Chapter 25).

APPROACH, ANALYSIS, TOOLS AND MODELING

Evaluation methods

1. Does the environmental impact analysis utilize appropriate evaluation methods? Were tools/analyses appropriate and described adequately?

As discussed in our response to the first set of charge questions, the DEIR/DEIS contains a great deal of information without condensing it into systematic comparisons of the impacts of alternatives that would help decision-makers, stakeholders, or the public reason their way through a complex series of options. Graphical remedies, illustrated by the diagram on page 5, would not be hard to include in the Final DEIR/DEIS. But beyond merely improving the Final DEIR/DEIS, detailed yet readily grasped comparisons of the alternatives are essential to facilitate the public process, manage expectations, and elicit meaningful public and policy discussions.

Above we noted impacts that the DEIR/DEIS mostly or entirely neglects (p. 6). Reasons to set aside these issues—of effects on San Francisco Bay, Delta levees, and irrigated agriculture—were not evident to us in the wealth of detail provided about the screening process.

In the Effects Analysis in the Draft BDCP's Chapter 5, the semi-quantitative results for each aquatic species are tabulated (e.g. Figure 5.5.1-5 for Delta smelt), but the final assessment of overall net effects is a qualitative interpretation of the tabulated effects. This analysis is highly uncertain because the combined importance of all effects was based on a subjective analysis of the attribute scores conducted by one set of experts. “Experts,” however, can include a broad range of perspectives and experiences; another group of experts might well reach a different conclusion (Appendix B, Chapter 11 review).

The hydrodynamic modeling appears to presuppose that any and all failed island levees would be quickly repaired. A more realistic approach would take cues from recent levee failures that have not been repaired. Simulations that include newly flooded islands may require three-dimensional modeling, but the results could be usefully applied to analysis of how levee failures would affect the various alternatives. At a minimum, where hydrodynamic modeling is premised on an optimistic assumption about levee repairs, that assumption should be stated prominently, and attending uncertainty should be carried forward into impact assessments.

The surface water modeling neglects interactions with ground water. While the repertoire of models employed appears acceptable for most cases, the reasoning of their selection ought to be concisely mentioned, given the large number of such models available for analyses. The limitations and assumptions of the models also should be noted.

The air-quality modeling excludes photochemical effects or any type of air quality modeling although earlier discussions greatly focus on photochemical pollutants and their transport.

For aquatic resources, inadequate attention was given to species interactions and food webs, particularly for non-covered species such as invasive clams.

Uncertainty

2. How well is uncertainty addressed and communicated?

Uncertainty is difficult to address and communicate for such a complex and dynamic series of actions. However, without some specific and balanced discussion of the general order of magnitude of error or uncertainty in major results, it is difficult for readers to make informed judgments about the various alternative actions.

Uncertainty is addressed and communicated more in the Draft BDCP than in the DEIR/DEIS, where conclusions are often stated without adequately acknowledging uncertainties or discussing how the project might prepare for or respond to a variety of outcomes. In some instances, uncertainties are used as an excuse not to assess possible outcomes of an action or use certain models (e.g. fish life cycle and bioenergetics models); in many other instances, uncertainties have not been carried forward as caveats to conclusions about impacts.

The DEIR/DEIS needs to address uncertainties more forthrightly so that scientific validity can be better assessed and stakeholder expectations can be better bounded. It may be possible, for instance, to assign a relative confidence level (such as A, B, or C) to many of the impacts listed in Table ES-9.

Greater care is also needed in conveying uncertainty about net effects. The issue here is whether the benefits of one Conservation Measure will counterbalance negative impacts of another Conservation Measure. In many instances, net effects are difficult to estimate reliably because of uncertainties in the magnitude and time-dependency of the individual effects. In many instances, it is even difficult to determine whether the effects of a conservation measure will be positive or negative.

Sensitivity to assumptions, uncertainty, and conflicting data

3. Do the analyses describe sensitivity of conclusions to assumptions and uncertainty and how possible conflicting data and analyses are interpreted?

There is some discussion of the sensitivity of conclusions to assumptions and uncertainty in the Draft BDCP and associated appendices, but that is not carried over into the DEIR/DEIS. Given the complexity of actions being proposed, the abundance of data, and the multitude of analysis techniques available, quantification of uncertainties will be difficult, but some estimates would be helpful. A simple formal decision analysis would likely help organize the problem and provide a framework for separating more from less important uncertainties and their effects on the relative likely performance of alternatives.

Many of the analyses need to spell out underlying assumptions in an easily identified format. In addition, where the assumptions are weak, the implications of this weakness ought to be mentioned. Bulleted lists of key assumptions could clarify:

- Error propagation in the hydrodynamic models (e.g., errors of initial and boundary conditions used for DSM2 and CALSIM II, errors from exclusion of ground-water interactions in the model, and errors from assumptions about locations of habitat restoration projects)
- Major limitations of the models used and conclusions reached
- Sensitivity of model results to an assumed configuration of restoration projects
- Assumptions about reservoir operations in the hydrodynamic models

- Assumptions about continued existence of some of the most subsided and least reliable Delta islands
- Assumptions about how adaptive management is likely to play out.

Places where bulleted, annotated lists of key assumptions would be helpful include:

- Chapter 6: DSM2 used for salinity-flow analysis is a one-dimensional model having inherent limitations in simulating open water areas, flow in bends and small channel, inlet/outlets and three-dimensional turbulent mixing, particularly with sea level decimeters higher than today's.
- Chapter 11: The implicit assumption of no interactions among the covered species as well as other abundance species such as the invasive clams weakens species-specific conclusions.
- Chapter 22: The best practice is to evaluate air-quality models used with existing data to document the uncertainties, but such procedures are either not followed or left undocumented.
- Chapter 23: The models used for noise analysis do not include the nocturnal atmospheric boundary layer effects, which surely will skew the inferences made.

Best available science

4. Is best available science employed in the environmental analysis of project alternatives and their effects?

DEIR/DEIS Chapters 5 to 30 vary in scientific rigor, scientific understanding, inclusion of relevant research findings, and citation of relevant reports. The chapters on Air Quality (Chapter 22) and Mineral Resources (Chapter 26), for instance, appear more robust scientifically than those on Geology (Chapter 9) and Public Health (Chapter 25) (details, Appendix B).

Each chapter and appendix needs a date stamp that describes when and how thoroughly it was last updated. Some of the impact assessments presented are several years out of date, as judged from the references cited (e.g. DEIR/DEIS Chapters 9, 10, and 12; Draft BDCP Appendices 3B and 5E). For instance, projections of tidal-marsh response to sea-level rise appear several years out of date (Appendix B, Chapter 12 review, tidal-marsh sidebar).

Articulation and reasonableness of assumptions

5. Are assumptions used in modeling and for analytical purposes clearly articulated and reasonable considering the complexity and current scientific understanding?

Many of the analyses need to spell out underlying assumptions in an easily identified format, as noted above under the heading "Sensitivity to assumptions, uncertainty, and conflicting data" (p. 11).

MONITORING AND ADAPTIVE MANAGEMENT

Adaptive management is essential for achieving the goals of the BDCP, and state law requires the Delta Stewardship Council to use "a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions" (§85307(f)).

Adaptive management, monitoring, and research are mentioned many times throughout the DEIR/DEIS, but ISB comments are based primarily on section 3.6 of the Draft BDCP, with additional discussion specific to each BDCP action in section 3.4. Appendix 3G of the Draft BDCP also has a section on monitoring, evaluation, and adaptive management. Administration of adaptive management is described in Chapter 7 and some comments on implementation of adaptive management are made throughout Chapter 6. Appendix 3D, deals with monitoring and research and provides tables listing potential compliance and effectiveness monitoring actions.

Direction from the Delta Stewardship Council provided us with two basic questions to address in evaluating how the BDCP incorporated adaptive management, monitoring, and research. As noted above, we consider adaptive management and monitoring in some detail in this response because of their critical importance to successful implementation of the BDCP.

Description and achievability

1. How well is the adaptive management strategy described and are the stated goals achievable?

Description of adaptive management

Adaptive management is described in section 3.6 as a three-phase process containing 9 steps. The overall characterization of adaptive management is consistent with standard works on the subject and with the treatment of adaptive management in the Delta Plan. Section 3.6 also describes issues in designing a robust adaptive management experiment, as well as the pitfalls in implementing an adaptive management experiment. The section clearly describes adaptive management and some of the issues that arise in trying to implement it.

Adaptive Management Team

Although adequate as a description of adaptive management, the process described in section 3.6 is not a strategy for implementation. In the Draft BDCP, the details of design and implementation of adaptive management are left to a future Adaptive Management Team, to be chaired by a Science Manager. The Science Manager is a new position established as part of the Implementation Office responsible for achieving the goals of the BDCP. The Adaptive Management Team is to be comprised of managers because, the Plan argues, adaptive management is fundamentally a management activity. We agree that the Adaptive Management Team should be comprised of managers because buy-in by managers is important to the success of adaptive management experiments. However, adaptive management is not part of the toolbox or the experience of most resource managers. Adaptive management experiments are like clinical trials in medicine—they have requirements for scientific insight and objective validity, planning, execution, time lines, and information gathering that differ from ordinary resource management.

Given the complexity of the scientific questions and uncertainties associated with implementing BDCP and the importance of adaptive management to successful implementation, the Science Manager must be well versed in the design and application of adaptive management and have the ability to interpret this way of implementing and managing conservation actions to

the Adaptive Management Team. It will also be important for the Science Manager to consult with the community of experts in adaptive management and to draw from the experience of practitioners involved in other large-scale adaptive management programs, nationally and globally. Most of all, the Science Manager must know when it is appropriate to use adaptive management and when it is not and realize expectations of what is and what is not achievable. Experience in design and implementation of adaptive management is not one of the qualifications of the Science Manager listed in Chapter 7—but it should be.

Adaptive-management experiments

No specific goals are stated for adaptive management beyond its basic purposes of assisting managers to manage uncertainty, and to learn about the systems they are managing through the management actions that they implement, and to adjust actions when appropriate. Because no specific adaptive management programs are described, it is not possible to determine whether the Plan will benefit from its use. The BDCP recognizes that adaptive management has failed in other situations for a variety of reasons, including failure to plan and model adaptive experiments properly, failure to implement adaptive management plans, failure to ensure adequate funding, failure to follow through with effective monitoring and scientific evaluation of adaptive experiments, and failure to coordinate planning and implementation among scientists, stakeholders, and managers (Walters 2007, Scarlett 2013). The Draft BDCP includes measures to prevent some of these failures. However, until a culture of adaptive management is developed in the participating agencies, implementation of the BDCP is likely to be thwarted by the kinds of obstacles that Walters (1997, 2007) and Allen and Gunderson (2011) describe.

Conducting adaptive management and designing robust management experiments will require a working set of models that link conservation actions to desired outcomes through species or ecosystem dynamics. The BDCP has employed a broad range of models in its effects analysis (described in Draft BDCP Chapter 5 and its appendices). However, it is not clear that these models are available or even suitable for designing adaptive-management experiments. For example, habitat suitability models are probably not sufficient on their own. It was not clear to us whether the Draft BDCP intends the Conservation Measures to be implemented *as experiments*, which is in actuality the heart of the adaptive management process. Instead, it appeared that uncertainties would be dealt with primarily through targeted research projects. It is important to frame adaptive management as experiments that provide opportunities to reduce uncertainty about subsequent restoration actions.

Assuming that the BDCP will, in at least some instances, implement Conservation Measures as experiments, it is important to have an objective way to decide when conducting such experiments makes sense. The Plan acknowledges that adaptive experimentation may not always be desirable but does not offer a clear approach to deciding whether to experiment or not. Because adaptive experimentation requires resources, one way to assess the benefits of a particular experiment is to compare the cost of conducting the experiment against the value of the information that will be gained from the experiment. If the value of the incremental reduction in uncertainty likely to result from an experiment is small relative to the cost of the experiment, it may make sense not to conduct the experiment but to frame adaptive management as an observational study supported by monitoring. Although it remains important to acknowledge the uncertainty, it is also important to recognize that the benefits of reducing uncertainty do not always justify the costs of experimentation.

In some instances (which may be commonplace in the Delta) adaptive experimentation may not be possible: conservation actions may be confounded with one another; control over drivers of change may be lacking; or physical, legal, financial, or social factors may constrain, individually or collectively, the range of options that can be explored. In such circumstances, other approaches to implementation may be better than adaptive management. Several such situations and possible alternative approaches are discussed by Williams et al. (2009) and Allen and Gunderson (2011).

Still other issues will likely affect the application of adaptive management in the Delta, many of them stemming from the complexity of the BDCP and the potential for confounding and conflict among objectives, actions, and outcomes. Some Conservation Measures may benefit one species but may harm another. And although progress towards biological goals is a means to assess the effectiveness of a Conservation Measure, there also need to be triggers to reverse negative impacts. These complications reinforce the need for the Science Manager to have a firm grasp of the potential and pitfalls of adaptive management and an appreciation of continually emerging approaches to managing complex systems.

Adequacy of monitoring

2a. Is the proposed monitoring adequate to evaluate if the goals and objectives are being achieved?

BDCP identifies three kinds of monitoring: compliance monitoring, effectiveness monitoring, and status and trends monitoring. Although this is a logical way of classifying monitoring activities, it does not necessarily mesh well with adaptive management. Adaptive management is designed to generate information that will clarify uncertainties in understanding the dynamics and responses of species and ecosystems to management actions. In some cases the required monitoring might not fit into any one of the three categories.

Compliance monitoring includes monitoring for regulatory compliance and compliance with design standards for Conservation Measures. Potential compliance monitoring actions for each conservation measure are listed in Table 3D-1. Monitoring of design-standard compliance is fairly straightforward, being dictated by specifications in a Conservation Measure. Monitoring for regulatory compliance can be more complex as can, for example, monitoring to ensure compliance with flow or water-quality design criteria. As the design criteria and outcomes for most Conservation Measures are not yet developed, it is difficult to say whether the compliance monitoring actions listed in Table 3D-1 are both necessary and sufficient.

Effectiveness monitoring and status and trends monitoring are combined in Appendix 3D and potential monitoring actions for each Conservation Measure are listed in Table 3D-2 of the Appendix. In the preamble to Table 3D-2, it is stated that “Precise details of each of the effectiveness monitoring actions are not presented here and will be developed and then periodically updated through the adaptive management and monitoring program.” Consequently, it is difficult to comment on the adequacy of the proposed monitoring actions at this time. However, Table 3D-2 does not provide any meaningful clues as to how the proposed monitoring will tie into any adaptive management experiments. Without explicit linkages between monitoring and the adaptive management practices it is intended to support, it is difficult to see how adaptive management can really be achieved.

Section 3.4 of the Draft BDCP discusses each of the 22 Conservation Measures in turn and repeats some of the potential compliance and effects monitoring actions identified in Tables 3D-1 and 3D-2. In addition, for some Conservation Measures, section 3.4 provides a table of "key uncertainties" and suggested research projects to address them. Because uncertainty is central to the impetus to adopt adaptive management, we examined section 3.4 for indications of how adaptive management would be used to address the key uncertainties. We found several peculiarities in the treatment of key uncertainties.

1. Key uncertainties are identified for only 8 of the 22 Conservation Measures. For the others, the Chapter specifically states that no key uncertainties (or needed research) were identified. Given the high uncertainty associated with *all* of the Conservation Measures, we find this statement insufficient.
2. Even where key uncertainties are identified, they seem to misrepresent the broad range of uncertainties inherent in a Conservation Measure. For example, only two key uncertainties are identified for CM-2, Yolo Bypass Fishery Enhancement: (a) the effectiveness of Yolo Bypass modifications, and (b) the effects of increased frequency and duration of flooding in the bypass on the health and vigor of riparian vegetation. Uncertainty (a) is vague and, in our view, does not in any sense capture the extent and variety of uncertainties inherent in a major change in hydrology, floodplain inundation, and habitat configuration, and in its effects within and beyond the Bypass. Uncertainty (b) depends on the determination of "health and vigor of riparian vegetation," which are largely subjective terms.
3. Key uncertainties that are identified are all to be addressed through targeted research projects rather than being incorporated into the adaptive management program. Although it may be more efficient to address some uncertainties through targeted research, many could be more effectively addressed in the context of a proper adaptive management design. This possibility does not seem to be considered in the Draft BDCP. A principal strength of adaptive management is that it allows managers to design their day-to-day management actions to provide critical information on key uncertainties. The BDCP does not appear to take advantage of this strength. Perhaps the responsibilities of the Adaptive Management Team are to include such design considerations. This would be appropriate but, if so, the text should reflect this responsibility. This concern applies not only to the design of adaptive management experiments but also to the clarification of key uncertainties.
4. Another benefit of incorporating uncertainties into a broader adaptive management plan is that individual uncertainties and outcomes can be linked to one another. The Delta is an interconnected system, and actions in one region are affected by actions in other regions. Although targeted research will often be the best option, it will be important to embed these efforts in a broad and holistic adaptive-management framework to address the inter-connectedness.

Although the Draft BDCP does not appear to make effective use of an adaptive management process, the monitoring and research activities described may still be sufficient to measure progress toward achieving the BDCP objectives. Given how the Draft BDCP is structured, however, it is difficult to determine if this is the case. In assessing the suitability of monitoring, there is a logical flow of relationships from conservation objectives, to actions to achieve those objectives, to expected outcomes from the actions, to monitoring to detect those outcomes, and then to evaluating criteria for success or failure and finally to making adjustments

as needed. These components do not seem to be associated in this way anywhere in the Draft BDCP, even though its Chapter 3 describes the necessary variables. In Table 1 below we have combined some information from two different tables to illustrate the relationship between objectives, actions, outcomes, and monitoring for CM-4 (Tidal Natural Communities Restoration). A similar assessment could be done for other Conservation Measures.

Table 1. Examples of biological objectives, how a Conservation Measure advances those objectives, proposed monitoring actions, metrics to be measured during monitoring, and the proposed criteria for success. Compiled from Tables 3.4.4-1 and 3.4.4-3 for CM-4 (Tidal Natural Communities Restoration).

Objective	How action advances the objective	Monitoring action	Relevant metric	Success criteria
L2.5: Maintain or increase the diversity of spawning, rearing, and migration conditions for native fish species in support of life-history diversity.	Tidal restoration is expected to improve some rearing habitat elements for Chinook salmon, Sacramento splittail, longfin smelt, delta smelt, sturgeons, and possibly steelhead. Tidal natural communities restoration in West Delta ROA is also expected to improve future rearing habitat suitability for delta smelt within the anticipated eastward movement of the low-salinity zone with sea-level rise.	Site level assessment	Use of restoration sites by covered fish species	Detection of site use by Chinook salmon, splittail, and the following covered fish species: longfin smelt and Delta smelt in the Suisun Marsh, West Delta and Cache Slough ROAs; steelhead in the West Delta, Cache Slough and Cosumnes/ Mokelumne ROAs
L2.7: Produce sinuous, high-density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.	Where feasible, tidal restoration projects will be designed to meet this objective. This habitat element will provide direct foraging opportunities for salmon and splittail and, with sufficient amounts of restoration, may provide prey for pelagic fishes.	Site level assessment	Tidal natural community geo-morphology	Presence of sinuous, high-density, dendritic networks of tidal channels through tidal areas
L2.9: Increase the abundance and productivity of plankton and invertebrate species that provide food for covered fish species in the Delta waterways.	Restoration of tidal natural communities is expected to improve some rearing habitat elements for Chinook salmon, Sacramento splittail, longfin smelt, delta smelt, sturgeons, and possibly steelhead.	Plankton and invertebrate sampling in restored habitats	Plankton and invertebrate abundance in restored floodplain	Presence within and transport from restored tidal natural communities to adjacent open-water habitat occupied by covered fish species

This example table illustrates the logical connections among conservation objectives, restoration actions, anticipated outcomes, and proposed monitoring. Perhaps at this stage in the planning that is the best one can expect. At a more detailed level, however, a multitude of questions remains. Consider Objective L2.5, "Maintain or increase the diversity of spawning, rearing, and migration conditions for native fish species in support of life-history diversity." Without questioning whether this objective is meaningful as a way to strengthen the viability of covered fish species, knowing whether one has achieved the objective depends on knowing the current diversity of spawning, rearing, and migration conditions for native fishes (what are the metrics for these attributes of habitat?), knowing that this diversity of habitat supports life-history diversity (what are the metrics of life-history diversity?) and knowing that restoring tidal natural communities will increase habitat diversity for native species in ways that do, indeed, strengthen life-history diversity.

Similar comments could be made about the objectives to create networks of dendritic channels in restored tidal marshes and to enhance plankton production to provide food for covered fish species. Is measuring the presence of dendritic networks sufficient or should the amount (or minimum amount on an absolute or percentage basis) of sinuous networks be the goal? Similarly, will the presence of plankton and invertebrates provide enough information to assess success? It may be better to have benchmarks (e.g., 20% increase over some period of time). It will also be important to consider the composition of the plankton and invertebrate assemblages because organisms are not equal in their food value.

The proposed monitoring touches only superficially on these objectives. Our purpose in pointing out these complexities is not to nit-pick about Conservation Measures but to illustrate that the objectives are more nuanced and the potential outcomes more complex than suggested by the proposed monitoring. At this stage we cannot say whether the proposed monitoring is necessary and sufficient to evaluate whether the goals and objectives are being achieved. We assume that the Adaptive Management Team will further refine the goals and objectives. Such refinement, and the validation of monitoring actions, would be greatly strengthened if the models linking objectives to outcomes were more clearly presented. Ultimately, the monitoring needs to determine how well the 22 Conservation Measures combined affect the health and productivity of the covered species.

Managing adaptive management

2b. Are the data management, analysis, reporting, and decision-making processes adequate to create a defensible and transparent implementation of adaptive management?

<u>Decision-making</u>

In the Draft BDCP, sections 3.6.4 and 7.3.4 address issues of data management, analysis, and reporting. The proposed administrative structure for BDCP is hierarchical. At the top, providing oversight and dispute resolution, is the "Authorized Entity Group" consisting of representatives of DWR, Reclamation, and Water Contractors. State and federal fish and wildlife agencies will participate in a "Permit Oversight Group," which will ensure regulatory compliance with Draft BDCP authorizations. Implementation of the Draft BDCP, including adaptive management, monitoring, and research, will be the responsibility of a newly created Implementation Office headed by a Program Manager who will report to the Authorized Entity Group. A key individual in the Implementation Office will be the Science Manager, who will

report to the Program Manager and will have responsibility for guiding and facilitating adaptive management, monitoring, and research. In this capacity, the Science Manager will chair an Adaptive Management Team. The Adaptive Management Team will include representatives of DWR, Reclamation, CVP and SWP water contractors, CDFW, USFWS, and NMFS. The IEP Lead Scientist, the Delta Science Program Lead Scientist, and the Science and Research Director of NOAA Fisheries' Southwest Fisheries Science Center are to be nonvoting members of the Team.

The Adaptive Management Team will take the lead in developing a framework for monitoring and will enlist the assistance of the Interagency Ecological Program (IEP) in implementing the program. The Science Manager and the Adaptive Management Team will develop and implement a process for compiling, evaluating, and synthesizing the results of monitoring and will prepare a plan to maintain databases of monitoring and synthesis results. The Adaptive Management Team will also manage the BDCP research program in coordination with IEP and the Delta Science Program. The Team will identify research priorities and will administer a process to select and coordinate the researchers who will be involved in the program. In addition, the Adaptive Management Team will be responsible for the compilation and synthesis of the results of studies and analyses undertaken by other organizations that are assisting in the implementation of the Draft BDCP. The Science Manager will ensure that BDCP science activities, reporting, and reviews are coordinated with other science activities being conducted in the Delta. Based on these analyses, the Adaptive Management Team will recommend to the Program Manager any necessary changes in the Draft BDCP or the Conservation Measures.

Overall, this decision-making arrangement does not seem to bring enough authority and resources for adaptive management to be implemented decisively and in a timely way. With this structure, each cycle of adaptive management would probably occur very slowly, if at all.

Data management

This proposed administrative structure centralizes—in the Adaptive Management Team and the Science Manager—the key administrative decisions regarding adaptive management, monitoring and research, data management, analysis, and development of recommendations concerning science-based modification to the BDCP. If the individuals involved have the appropriate skills and the independence needed to critically evaluate project effectiveness, and if provisions are made to link data management and data bases with existing relevant data bases (both in-house and external to the main agencies involved in BDCP), then the centralized system should be effective. The BDCP envisions making use of the science synthesis approaches developed in the Delta Science Plan and working with the Delta Science Program to assemble, analyze, and synthesize the large volume of data that will be accumulated. We endorse this approach. We also support ensuring that the BDCP data are publically available so outsiders can make their own analyses.

Large volumes of data will be generated as BDCP is implemented, but BDCP is only one of many activities in the Delta that will be generating voluminous scientific data. A distinguished panel found that as of 2012, "science efforts related to the Delta are performed by multiple entities with multiple agendas and without an overarching plan for coordinating data management and information sharing" (National Research Council, 2012). Goals of the Delta Science Plan include coordinated data management and sharing among agencies involved in

Delta science. The BDCP's scientific work should be tightly integrated with the Delta Science Program to ensure that science and data management for the BDCP follow the "One Delta, One Science" concept, which will provide benefits to all parties, particularly regarding the credibility and transparency of scientific work overall.

It may be difficult to ensure that the appropriate skill sets are present in the Implementation Office. We have already noted that the listed qualifications for the Science Manager do not include expertise in adaptive management. Because this is a new position, this shortcoming is easily corrected. However, personnel for the Implementation Office, which will provide the staff to manage the databases, analyses, modeling, etc., will be drawn from existing staff in DWR and other state agencies. The BDCP needs a staffing plan that dovetails with the need to strengthen the agencies' capabilities in field observations, data management, modeling, and synthesis.

Timing

In a key role not identified in the documents, the Science Manager and Adaptive Management Team should identify the goals and objectives for monitoring, the desired outcomes, and an adaptive framework for evaluating when outcomes have been met. In Table 3.E-2, Effectiveness Monitoring Actions are described, for example, and in some cases the timing and duration for monitoring are described. Without knowing the response rates of the system, or how different restoration actions and climate change will interact with the desired outcomes, it does not seem feasible to establish a specific timeframe. Rather, the described timeframes should be viewed as initial guides that will be revised depending upon outcomes, since it may take more (or less) time for outcomes to be realized.

Adaptive-management decisions often must be made quickly, yet implementing the full 9-step adaptive management process can be ponderously slow, especially when encased in a hierarchical organizational structure. There is the potential to exacerbate a science-policy conflict: scientists often want to obtain deeper knowledge about complex details, whereas managers and policy-makers are interested in reaching decisions about which actions to take and where best to allocate resources (the "more research" vs. "just do it" conflict). Consideration should be given to how to make adaptive management flexible and nimble, yet still scientifically rigorous.

Adaptive management will need to keep pace with change in the Delta. One strategy is to use model projections of future conditions to anticipate how practices might need to change to fit future conditions—"anticipative" adaptive management. Vlieg and Zandvoort (2013) have contrasted this approach, which is practiced in the Rhine-Meuse Delta in the Netherlands, with the "reactive" adaptive management proposed for the Delta, suggesting that a hybrid of the two approaches might be best. Because the details of adaptive management in BDCP have yet to be developed, there is an opportunity to consider these ideas.

Collaboration

Although the Draft BDCP acknowledges the need to coordinate adaptive management with the Delta Science Program, it largely ignores the framework for adaptive management developed in the Delta Plan and (especially) the Delta Science Plan. Instead, an operational structure is described that is almost entirely within the BDCP governance organization, as outlined in Chapter 7 of the Plan. This contrasts with a growing recognition of the need to

engage a wide array of people and entities in a truly "collaborative adaptive management" (Susskind et al. 2012, Scarlett 2013). A Collaborative Science and Adaptive Management Program (CSAMP) and Collaborative Adaptive Management Team (CAMT) were formed in mid-2013 to develop a robust science and adaptive management program, primarily to inform the implementation of the current Biological Opinions applicable to the Delta[8]. Although these groups were formed too recently to be included in the Draft BDCP documents, their relations to the adaptive management structure proposed for BDCP should be included in the Final documents.

Funding

Funding for adaptive management can also become a contentious issue (Walters 2007). The Plan (Chapter 8) identifies a budget on the order of $500 million for monitoring (both compliance and effectiveness monitoring) and an additional ca. $400 million for research (Tables 8-30 and 8-31). No funding is specifically earmarked for adaptive management in the Plan. This is appropriate, as adaptive management should be an integral part of planning and implementation for all the Conservation Measures, not a separate activity. However, adaptive management planning and implementation cost more than traditional management, both in personnel and capital expenditure, as synthesis and changes in management must be actually and routinely implemented. It is not clear that these extra costs were included in the budget for the Implementation Office. Chapter 3 identifies a separate "supplemental adaptive management fund" of at least $450 million (section 3.4.23.5) that could be accessed if other resources are insufficient or cannot be accessed to support an adaptive change in Conservation Measures. Apparently, these funds are not available, however, for routine costs of management. The budgets presented in Tables 8-30 and 8-31 were based on estimated staff and resources required to undertake the monitoring and research actions listed in the Plan plus an additional $140 million to cover monitoring and research needs not identified in the Plan. How the supplemental adaptive management fund budget was determined is not clear.

Although the budget for monitoring and research is substantial, it is actually small compared with BDCP's total cost. Even a budget of this size could easily be exhausted by the multitude of possible monitoring and experimental actions for each Conservation Measure. The Draft BDCP has identified a broad range of possible monitoring and research actions related to the Conservation Measures. But the Draft BDCP also acknowledges that these will need to be reconsidered as the detailed implementation plans develop. The Adaptive Management Team will have the difficult task of determining how to allocate the inevitably limited resources for monitoring and research. Difficult trade-offs are inevitable, highlighting the need to develop an objective, rigorous, and transparent process for prioritizing monitoring and research activities.

A great deal of planning and evaluation will be required during the early years of implementation. We envision a need for further analyses to clarify conservation actions and how to fit these into an adaptive management program, pilot testing of some conservation actions, negotiations for land acquisition, and many other tasks necessary to finalize the conservation program. This suggests a front-loading of activity in the Implementation Office. However, on an annualized basis the budget for the Implementation Office does not differ much across the 50-

[8] http://deltacouncil.ca.gov/sites/default/files/documents/files/Item_7_Attach_1_CAMT%20Progress%20Report%20Version%206_0%20140207.pdf

year term of the project. We suggest evaluating whether additional funds should be allocated for up-front planning and evaluation, including development of suitable interagency data, modeling, and monitoring capabilities.

Contingency plans

Monitoring and adaptive management are proposed to evaluate whether conservation actions are achieving their intended objectives. What if things do not go as planned? The history of ecological restoration shows that restoration projects rarely have exactly the intended consequences in the expected time frame. Section 3.4.3.4.2 in the Draft BDCP states that contingency measures will be developed for site-specific conservation actions to be implemented in the event that success criteria are not met. However, the Draft BDCP also states that these contingency measures differ from adaptive management because they are site-specific and targeted at meeting success criteria. Similar contingency plans are mentioned for other Conservation Measures throughout section 3.4. There will inevitably be situations, however, in which the adjustments are not possible or incur too great a cost or where there is a large-scale failure of restored habitat to function as anticipated. What happens then?

Given the complexity and the high stakes of many of the actions to be undertaken in BDCP, it would seem prudent to have contingency plans and action thresholds at least generally outlined *before* discovering that things are not working as planned. There is no mention of contingency plans in section 3.6, which describes adaptive management. Contingency planning is not mentioned in Draft BDCP Chapters 6 and 7 (Plan Implementation and Implementation Structure) nor in the DEIR/DEIS. The Draft BDCP should build contingency plans into the adaptive management process.

Additional comments

Steps toward adaptive management in Appendix 3G

1. Page 3, lines 32-37: "An equally important purpose of this memorandum is to introduce a simple deterministic, stage-based life cycle approach to define BDCP objectives, periodically review and update them, and monitor progress toward achieving the intermediate and final Cohort Replacement Rate (CRR) milestones.....it is imperative to establish interim objectives in order to guide monitoring and the management decision making process in the near term."—Without using the term, this statement outlines the beginnings of an Adaptive Management Program. Page 6 goes on to list general assumptions and then introduces the models to be used. Uncertainty is discussed in the Introduction as well.
2. Page 8, lines 25-27: “Where species-specific data were available they were used directly. More often, this will not be the case and adjustments were made based on how different life history characteristics would be expected to influence survival.”—This is followed by assumptions, by data from other areas that lend support to the assumptions, and by statement of future challenges in model modification. This is probably the best that can be done under the circumstances. The approach seems to fit into the early steps of the adaptive management process.
3. Page 11, lines 9-13: "There are several other factors that might be considered in further defining or revising these Interim Survival Objectives, including scaled objectives based on wet and dry years. However, at this point we are reluctant to more finely define or scale

survival objectives until additional species-specific survival estimates are collected over a range of hydrologic conditions. However, as new information becomes available, the potential to define wet and dry year expectations should be revisited."—Again, this statement both acknowledges and contributes to the adaptive management process. Likewise, climate change is presented as an uncertainty issue in terms of future annual variability scenarios.

Broad questions

1. What strategies for funding and oversight of monitoring and adaptive management will best promote credibility and independence in the science supporting adaptive management?
2. What kinds of management actions will be subject to adaptive adjustment? Are both operations and habitat Conservation Measures subject to adaptive management?
3. What future conditions are likely to prompt adaptation? The draft mentions sea-level rise and changes in Delta outflow requirements. Other futures worth considering include the flooding of additional subsided islands, requirements for upstream reservoirs to release cold water, tightened water-quality standards for byproducts of disinfection, and salinity regulation for Delta and south-of-Delta agriculture.
4. Will requiring the Adaptive Management Team to reach consensus be unrealistic and lead to delays or inaction?

Other remarks on Draft BDCP Chapter 3

1. The interaction between the Adaptive Management Team and the Implementation Team is critical for the success of the 9-step adaptive management process described in section 3.6.3.4. More details should be provided about how these two teams will interact in actually doing adaptive management.
2. In section 3.6.3.5.4 it is stated, “The adaptive management and decision-making processes described in this section do not apply to these real-time operations.” How will this limitation affect the adaptive management plan as a whole?
3. Appendix 3E-7, lines 6-8: "Precise details of each of the effectiveness monitoring actions are not presented here and will be developed and then periodically updated through the adaptive management and monitoring program (Section 3.6)."—In terms of effectiveness monitoring, this is not an unexpected response. Some specific monitoring actions are mentioned in Table 3E-2 but these are general and often repetitive.
4. Research questions in Table 3E-3 are broad, and in some cases somewhat repetitive in terms of data already being collected in the Delta (which would require reanalysis or a meta-analysis). The document acknowledges that these will be modified over time.

STATUTORY QUESTIONS

Scientific basis and clarity

1. *Comment on the scientific basis and clarity related to the EIR-EIS conclusions:*

Issues of clarity are considered above, under "Completeness, structure, and effectiveness of presentation" (p. 4-7), and in our overview. The responses below, on the scientific basis for the conclusions, draw on the resource-chapter reviews in Appendix B, to which we refer the reader for details.

Freshwater flows

a. the review and analysis of the range of flow criteria, rates of diversion, and any other operational criteria required to satisfy the criteria for approval of a natural community conservation plan as provided in subdivision (a) of Section 2820 of the Fish and Game Code, and other operational requirements and flows necessary for recovering the Delta ecosystem and restoring fisheries under a reasonable range of hydrologic conditions, which will identify the remaining water available for export and other beneficial uses.

DEIR/DEIS Chapter 5 examines the changes in surface water operations and deliveries that would likely accompany each of the project alternatives. For each alternative, results for Delta outflow, exports, project deliveries (north and south of the Delta), and major surface reservoir storage are presented. The modeling approach uses CALSIM II, with additional temperature and Delta flow and salinity modeling, for a particular climate change scenario (sea level rise and climate warming), averaging a wide range of potential climate warming scenarios for conditions around the year 2060.

The analysis of this complex problem for a wide range of alternatives is inherently difficult and potentially confusing. The analysis presented is more advanced than is typically seen for project evaluation in employing climate change scenarios. This implies some uncertainties, as system operating rules and environmental regulations are likely to change as well with climate. The modeling results are reasonably good, though unavoidably imperfect. However, the model results are overwhelming in quantity, not well summarized, and insufficiently linked to interpretation. An explicit comparison of the range of water deliveries for major user locations (project and non-project) over the range of wet and dry conditions would be valuable.

Chapter 5 provides little comparative summary of impacts on water supply. This shortcoming limits the ability of this analysis-filled chapter to contribute to thoughtful discussion and comparison of the alternatives. There seems to be little difference between 6,000 cfs and 9,000 cfs alternatives, presented, though deliveries for the 3,000 cfs tunnel capacity are much less. Much of the difference among alternatives seems likely to be driven as much or more by operating and regulatory policies than by infrastructure capacities. This should be a topic of meaningful discussion.

The major analytical problem is the gap between CALSIM-II modeling of the water-supply system and actual operations. The State Water Project and Central Valley Project account for only a part of the water management decisions and impacts in this vast system. DWR and USBR modeling has improved considerably in recent decades but remains centered on the SWP

and CVP. This limited modeling therefore largely ignores or oversimplifies most water management decisions in California, which are those taken by local and regional governments and water users. The limited modeling thus seems inadequate for impact analysis of a system governed largely by local agencies.

Related to this problem is the continuing evolution of the CALSIM model and its variants. MBK modeling presented to us in the January 2014 meeting of the ISB highlighted differences in results that reflect both model evolution and modeler judgment. The MBK results (which still remain unpublished and proprietary) also highlighted the complicating effects of operational decisions and of the regulations that govern them. (Delays in making these results public are interfering in the ability to consider these results.) According to Mount et al. (2013), current regulations would limit flexibility for operations of dual facilities.

Climate change

b. the potential effects of climate change (including possible sea level rise up to 55 inches), and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the EIR.

The reviewed documents explicitly consider how climate change may affect water supply and ecosystems, and how the proposed Conservation Measures may act to lessen these effects. However, the likelihood and magnitude of these effects and of the associated uncertainties need to be stated or addressed more clearly in several respects: synergistic effects triggered by climate change; changes in frequency and impacts of extreme events and extreme conditions; and the range of plausible impacts on the effectiveness of the Conservation Measures (review of Chapter 29 and tidal-marsh sidebar in review of Chapter 12). There will be considerable uncertainty as to how water system operations, levee maintenance, environmental regulations, and water demands will react to climate change. In all areas, considerable changes should be expected, although the exact responses are now unavoidably uncertain.

Fish and aquatic resources

c. the potential effects on migratory fish and aquatic resources.

Please see our Appendix B for a detailed review of DEIR/DEIS Chapter 11. Concerns expressed there include:

1. The chapter needs to consider impacts from an ecosystem perspective. The existing analysis by Conservation Measures and individual species, although perhaps necessary, neglects the co-equal goal of *ecosystem* health. Success will depend on a fully functioning system, and therefore on analyses that incorporate integration and interaction across species, within a species, and across regions.
2. Positive and timely benefits of habitat restoration are highly uncertain. Failure to realize these benefits will invalidate the final conclusion of no net negative effect.
3. Full life cycles receive too little attention, as do effects of flow on entrainment.
4. The qualitative nature of the effects analysis aligns its results more with "hypotheses" than with "conclusions" or "predictions."
5. Uncertainty in the analyses needs to be carried forward, underlying assumptions need to be stated more explicitly, and hypotheses need to be distinguished more clearly from conclusions.

6. Adaptive management of migratory fish and aquatic resources will require a well-planned and comprehensive program of research and monitoring that will target causality and test hypotheses in the Draft BDCP. The decision-tree process is not adequately described.

Water quality

d. the potential effects of each Delta conveyance alternative on Delta water quality

The DEIR/DEIS analyzes all Delta conveyance alternatives for their potential impacts on water quality. The analyses generally conclude that the different alternatives would not alter water quality appreciably, for most constituents of concern. Our review of Chapter 8 describes concerns about these findings, including:

1. Some of the analyses hinge on comparison of data from different environmental monitoring programs that differ vastly in limits of detection. The DEIR/DEIS draws conclusions that are likely incorrect because they are based on non-detects of analytes.
2. The models used to estimate changes in water quality are likely to have uncertainty, particularly under future conditions with more complex hydrodynamics due to climate change and likely changes in Delta levees.
3. The chapter relies on existing water quality guidelines to determine ecological harm. Such guidelines are increasingly recognized as being inadequate to protect against loss of ecosystem function.
4. The chapter ignores water-quality impacts of providing a more reliable water supply for agriculture. While the DEIR/DEIS does consider economic benefits to agriculture, the consequences to water quality of increased use of fertilizers and pesticides have not been considered. Surprisingly, there seems to be no quantification or comparison of the effects of project alternatives on salt exports to the West side of the San Joaquin Valley.

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APPENDIX B

Comments by the Delta Independent Science Board

on individual chapters

of the BDCP Draft Environmental Impact Report/Environmental Impact Statement*

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* Appendix B consists of comments on individual chapters of the DEIR/DEIS, provided by individual DISB members or subsets of DISB members. While most chapters have been reviewed by one or more members of the DISB, a few have not been reviewed. However, review of those few additional chapters would not alter the overall conclusions of the DISB regarding the scientific basis of the DEIR/DEIS.

ACRONYMS IN THIS APPENDIX

Acre Feet per year	af/yr
Air Quality	AQ
Avoidance and Minimization Measures	AMMs
Bay Delta Conservation Plan	BDCP
Bay Delta Conservation Plan public review documents	Draft BDCP
Best Management Practices	BMPs
Biological Opinion	BiOp
California Environmental Quality Act	CEQA
Contaminant of Emerging Concern	CEC
Central Valley Project	CVP
Conservation Measure	CM
Conservation Zone	CZ
Cubic feet per second	cfs
Delta Independent Science Board	DISB
Department of Water Resources	DWR
Disinfection By-Product	DPB
Draft of the BDCP Environmental Impact Report/ Environmental Impact Statement	DEIR/DEIS
Dissolved Organic Carbon	DOC
Delta Risk Management Strategy	DRMS
Electromagnetic Field	EMF
Export/Import Ratio	E/I ratio
Geospatial Information Systems	GIS
Greenhouse Gases	GHG
Interactive Object-Oriented 5 Simulation Mode l	IOS
National Environmental Protection Act	NEPA
National Research Council	NRC
Nitrogen: Phosphorous ratio	N:P ratio
Old and Middle Rivers	OMR
Polycyclic Aromatic Hydrocarbons	PAHs
Particulate Organic Carbon	POC
Polychlorinated Biphenyls	PCBs
Restoration Opportunity Area	ROA
San Francisco Estuary Institute	SFEI
San Joaquin River	SJR
Sacramento River	SR
State Water Project	SWP
Toxic Air Contaminants	TACs
Total Dissolved Solids	TDS
Total Phosphorous	TP
Total Suspended Solids	TSS
United States Bureau of Reclamation	USBR
United States Geological Survey	USGS
Water Quality Control Plan	WQCP
Wastewater Treatment Plant	WWTP

CHAPTER 3: DESCRIPTION OF ALTERNATIVES

I. Overall Assessment

Chapter 3 of the DEIR/DEIS has a fairly complete, but confused presentation of the alternatives. To better make sense of the alternatives, it was useful to re-order and organize these alternatives.

II. Scope

Three general strategies for Sacramento-San Joaquin Delta exports are examined:

- Through-Delta water exports (2 Alternatives, plus existing conditions),
- Dual exports with a combination of intakes south and north of the confluence of the Sacramento and San Joaquin rivers (SR and SJR, respectively) (11 Alternatives), and
- Peripheral exports exclusively from north-of-confluence intakes (3 Alternatives).

These Alternatives and existing conditions are summarized in Table 1 and mapped in Figure 1. With the exception of Alternatives 4, 7, and 8, the remaining Alternatives have a physical export capacity of about 15,000 cfs each. Each physical Alternative has a specific set of operating policies employed in its analysis. Dual conveyance, Alternative 4 (the Draft BDCP CEQA preferred Alternative), is examined with four operational scenarios. Habitat restoration actions often vary significantly between physical Alternatives, as summarized in Table 2. Variants in operating policies are summarized in Table 3. In addition, a separate discussion of Alternative 9, a(n) unique through-Delta Alternative, is included at the end of this discussion.

Table 1. Organized Summary of Alternatives

Alternative	Strategy	Conveyance Alignment	Physical Export Capacities (cfs)			Operations
			Total	North	Intakes	
Existing Conditions	Through Delta	Delta Cross Channel, sloughs, and reverse flows	15,000	0	South Delta	Existing conditions
No Action	Through Delta	Delta Cross Channel, sloughs, and reverse flows	15,000	0	South Delta	Includes sea level rise and climate warming
9	Through Delta	Separate Corridors, Screened at Delta Cross Channel and Georgiana Slough	15,000	0	South Delta	Scenario G
5	Dual	Pipeline/Tunnel	15,000	3,000	North & South	Scenario C, tidal habitat to 25,000 acres
3	Dual	Pipeline/Tunnel	15,000	6,000	North & South	Scenario A
4 (CEQA Preferred)	Dual	Modified Pipeline/Tunnel	15,000	9,000	North & South	Scenario H (4 variants)
7	Dual	Pipeline/Tunnel	15,000	9,000	North & South	Scenario E + 20 miles of channel margin habitat enhancement and 10,000 acres of seasonal floodplain
8	Dual	Pipeline/Tunnel	15,000	9,000	North & South	Scenario F + up to 1.5 MAF more Delta outflow
1A	Dual	Pipeline/Tunnel	15,000	15,000	North & South	Scenario A
1B	Dual	East Canal	15,000	15,000	North & South	Scenario A
1C	Dual	West with West side intakes	15,000	15,000	North & South	Scenario A
2A	Dual	Pipeline/Tunnel	15,000	15,000	North & South	Scenario B
2B	Dual	East Canal	15,000	15,000	North & South	Scenario B
2C	Dual	West with West side intakes	15,000	15,000	North & South	Scenario B
6A	Isolated	Pipeline/Tunnel	15,000	15,000	North Delta	Scenario D
6B	Isolated	East Canal	15,000	15,000	North Delta	Scenario D
6C	Isolated	West, with West side intakes	15,000	15,000	North Delta	Scenario D

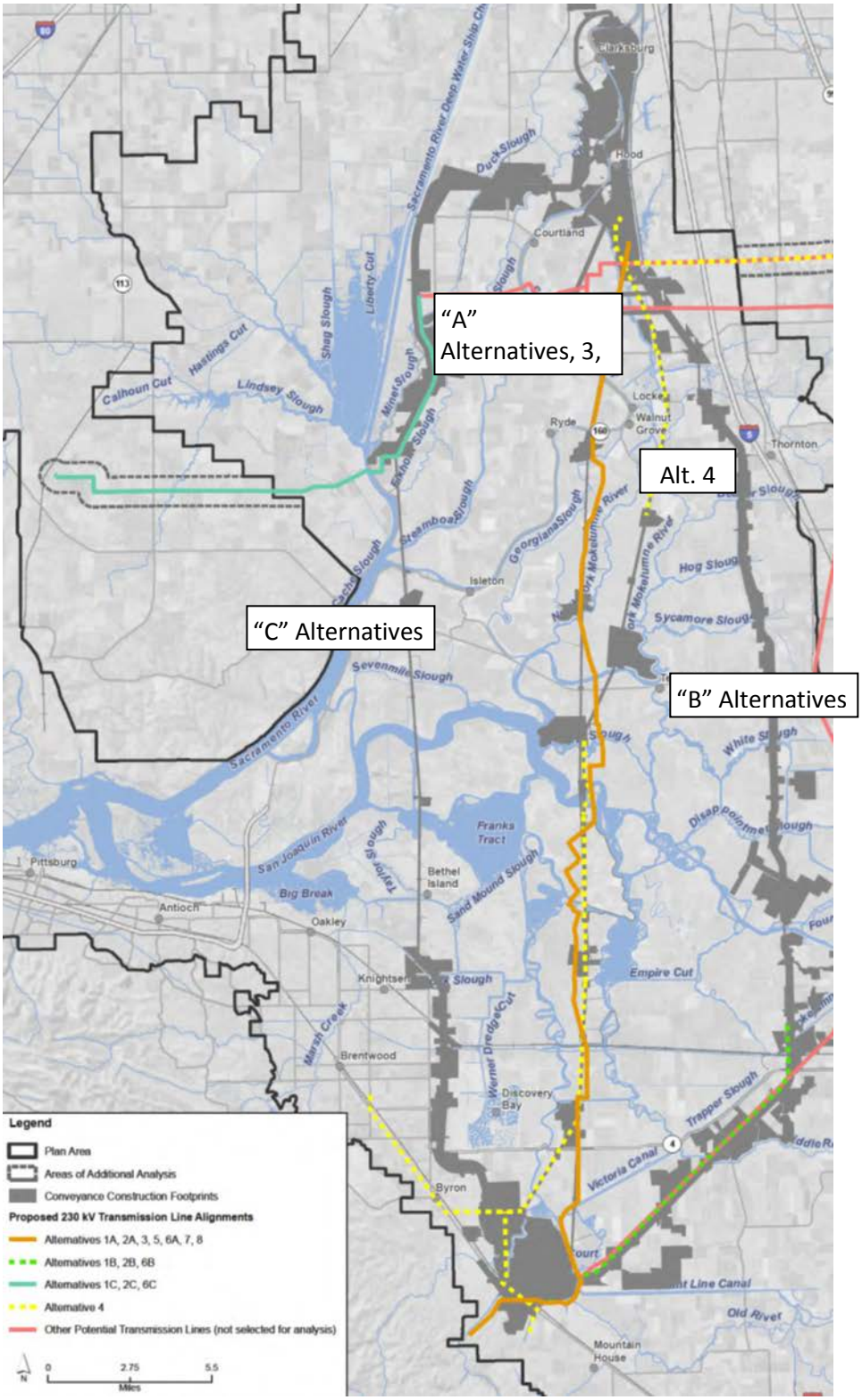

Figure 1: Conveyance Alignments for Alternatives 1-8 [needs redrafting]

Table 2. Summary comparison of conservation component acreages and variations among the Alternatives (after Table ES-8 and Section 3.6.2)

Conservation Component	Variations
65,000 acres of restored tidal perennial aquatic, tidal mudflat, tidal freshwater emergent wetland, and tidal brackish emergent wetland natural communities within the Draft BDCP ROAs (CM4).	Alternative 5, reduced to 25,000 acres. Alternative 9, expect different locations for restoration or enhancement activities.
10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or South Delta ROAs (CM5).	Alternative 7, expand to 20,000 acres of restored seasonally inundated floodplain fish and wildlife habitat, particularly along the San Joaquin River. Alternative 9, expect different locations for restoration or enhancement activities.
20 linear miles of channel margin habitat enhancement in the Delta (CM6).	Alternative 7, expand to enhancement of 40 linear miles of channel margin habitat Alternative 9, expect different locations for restoration or enhancement activities.
5,000 acres of restored native riparian forest and scrub habitat (CM7).	Alternative 9, expect different locations for restoration or enhancement activities.
2,000 acres of restored grassland and 8,000 acres of protected or enhanced grassland within Draft BDCP CZs 1, 8, and/or 11 (CM8 and CM3).	
Up to 67 acres of restored vernal pool complex and 72 acres of restored alkali seasonal wetland within CZs 1, 8, and/or 11(CM9), 600 acres of protected vernal pool complex within CZs 1, 8, and/or 11 (CM3).	
1,200 acres of restored nontidal marsh within CZs 2 and 4 and/or 5, and the creation of 320 acres of managed wetlands (CM10).	
50 acres of protected nontidal marsh (CM3).	
150 acres of protected alkali seasonal wetland complex in CZs 1, 8, and 11 (CM3 and CM11).	
1,500 acres of protected managed wetlands (CM3 and CM11).	
5,000 acres of protected managed wetland natural community (CM3).	
45,405 acres of cultivated land (non-rice) and up to 1,500 acres of cultivated land (rice) protected (CM3 and CM11).	
Operable barrier (with boat lock) at the head of Old River would prevent returning and outmigrating salmon from entering Old River to minimize exposure to S. Delta pumping. Partially closed gate flow would pass through the fishway traversing a series of baffles.	Only for Alternatives 2A, 2B, 2C, and 4

Operating polices

The operational scenarios are described briefly below and in more detail in Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*.

- Scenario A (Alternatives 1A, 1B, 1C, and 3) includes most No Action objectives for South Delta exports and required Delta outflow, new criteria for North Delta diversion bypass flows, and assumed operations of the proposed Fremont Weir (notch) during high SR flows; this scenario does not include Fall X2 objectives or the SJR inflow/export ratio. Depending upon the time of year, the minimum bypass flow ranges from 5,000 to over 15,000 cfs. Different North Delta diversion capacities influence the volume of pumping from the South Delta and overall Delta operations.
- Scenario B (Alternatives 2A, 2B, and 2C) include the Fall X2 criteria, but not the SJR inflow/export ratio. Scenario B would also include less negative OMR flow limits, and an operable barrier at the head of Old River. All other No Action rules apply, and the north Delta intake bypass rules are as under Scenario A.
- Scenario C (Alternative 5) incorporates all the No Action rules and the north Delta intake bypass flow rules are as under Scenario A. The north Delta operations were limited because of a single 3,000 cfs intake on the Sacramento River.
- Scenario D (Alternatives 6) eliminates use of south Delta intakes and uses only the same north Delta intake bypass flow rules as Scenario A. Existing south Delta export rules would not apply, including the E/I ratio. All the No Action outflow rules apply.
- Scenario E (Alternative 7) modified Scenario A criteria for bypass flows, Fremont Weir gate operations, Rio Vista minimum flows, Delta outflow, and south Delta export operations.
- Scenario F (Alternative 8) modifies Scenario E to include specific Delta outflow criteria and cold water pool management criteria for specific reservoirs.
- Scenario G is similar to Scenario A, but is modified to conform to the conveyance as separate surface corridors for Alternative 9, without north Delta intakes. Instead, water continues to flow by gravity from the SR into two existing channels, Delta Cross Channel and Georgiana Slough, without North Delta Diversion Bypass Flow Criteria and Operations for Delta Water Quality and Residence Time. The Delta Cross Channel and Georgiana Slough gates would open only under higher flow conditions, with operable barriers on the Mokelumne River system as well.

Diversion restrictions include:

1) 2009 NMFS BiOp: SJR inflow/export ratio that limits combined exports based on the SJR inflows in April and May. Limits on reverse OMR flow in December–June of many years (adaptively managed based on fish monitoring).
2) Minimum monthly Delta outflows specified in D-1641 for each month, depending on the water year type (i.e., runoff conditions).
3) Maximum salinity objectives specified in D-1641 for each month or period for water users
4) Spring X2 location objectives introduced in the 1995 WQCP. X2, specified by month and (unimpaired) runoff in the previous month.
5) 2008 USFWS BiOp included an outflow requirement for September- November of wet and above normal water year types. Fall X2 rule requires X2 at or downstream of Collinsville in above normal years and downstream of Chipps Island in wet years.

6) State Water Board has recently explored additional operational rules that would require Delta outflow to be a specified percentage of monthly unimpaired flow.
7) North Delta bypass flows: July–September 5,000 cfs, October-November 7,000 cfs in all years. December–June allow bypass flows to increase with river inflow. Low-level pumping of 6% of the river flow would be allowed most of the time, but major diversions could not begin until the SR flow exceeds a specified threshold.

In-Delta barriers

The existing South Delta Temporary Barriers Project consists of seasonal installation and removal of three temporary rock barriers in Middle River near Victoria Canal, Old River near Tracy, and Grant Line Canal near Tracy Boulevard Bridge. These rock barriers are designed to act as flow-control structures, trapping tidal waters behind them following high tide. These barriers improve water levels and circulation for local South Delta farmers. A fourth barrier, installed at the head of Old River at the divergence from the San Joaquin River, is designed to improve migration conditions for salmon originating in the SJR watershed during adult and juvenile migrations, which occur annually in the fall and spring, respectively. In the fall, the head of Old River barrier improves downstream dissolved oxygen conditions; during the spring, the barrier is intended to prevent downstream migrating salmon smolts in the SJR from entering Old River. In 2009 and 2010, DWR installed and operated a nonphysical barrier at the head of Old River as an Alternative to the spring rock barrier at this location. The nonphysical barrier uses underwater bubbles, light, and sounds as a behavioral deterrent and tests the effectiveness of excluding outmigrating smolts from entering the South Delta via Old River without having to physically block the flow of water into the channel with a rock structure. In the future, DWR may install and operate the nonphysical barrier at the head of Old River as an Alternative to the spring rock barrier.

Alternative 9 is a unique through-Delta Alternative with four separate flow corridors: (1) the North Delta separate water supply corridor that conveys water from the SR to Middle River; (2) the South Delta separate water supply corridor along Middle River and Victoria Canal that conveys water from the SJR to Clifton Court Forebay; (3) the San Joaquin separate fish movement corridor that provides flow for fish migration from the upper SJR to the lower SJR downstream of Franks Tract; and (4) the Mokelumne separate fish movement corridor that diverts from the Mokelumne River through Lost Slough and Meadows Slough to the SR. Two fish-screened intakes would be constructed: one each at the Delta Cross Channel and Georgiana Slough. Once in the channel, water would flow south through the Mokelumne River and SJR to Middle River and Victoria Canal, which would be dredged to accommodate increased volumes of water. Along the way, diverted water would be guided by operable barriers. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons, eventually reaching Clifton Court Forebay.

Alternative 9 includes the following water conveyance-related facilities:

- Operable barriers on the Mokelumne River near Lost Slough, Snodgrass Slough near the Mokelumne River, extension of Meadows Slough to the SR, and installation of an operable barrier on Meadows Slough. These facilities would provide a path for fish migration from the Mokelumne and Cosumnes Rivers through Lost Slough and Meadows Slough to the SR, except during flood flows.
- On-bank diversions with fish screens at the Delta Cross Channel and Georgiana Slough.

- A boat lock and channel at the diversion structure at Georgiana Slough.
- An operable barrier at Threemile Slough to reduce salinity in the SJR during low Delta outflow and potentially to reduce fish movement from the SR to the SJR.
- Operable barriers along Middle River at Connection Slough, Railroad Cut, Woodward Canal, and immediately downstream of Victoria Canal to isolate Middle River from Old River. Dredging would occur at each of these locations.
- Dredging along Middle River from Mildred Island to Victoria Canal and along Victoria Canal for a siphon to provide gravity flow into Clifton Court Forebay.
- Expansion and extension, through dredging, of Victoria Canal under West Canal, across Coney Island, and under Old River to Clifton Court Forebay.
- An Intertie Canal with a control gate between Clifton Court Forebay and the Tracy Fish Facility.
- Closure of the Clifton Court Forebay inlet gate from Old River except during flood flows.
- Closure of channel between Old River and the Tracy Fish Facility except during flood flows.
- Closure would include channel modification to allow continued access to River's End Marina from Old River.
- Operable barriers along the SJR separate fish movement corridor at the upstream confluence of Old River and the SJR (head of Old River), Fisherman's Cut at False River, and Franks Tract to isolate Old River (San Joaquin River separate fish movement corridor) from the SJR.
- A pumping plant on the SJR at the head of Old River to convey additional flows with organic material into Old River.
- A pumping plant on Middle River upstream of Victoria.

Table 3. Comparison of Operational Rules under Draft BDCP Operational Scenarios and Alternatives (after Table ES-7)

Operational Scenario and Alternative	**Months**	**No Action**	**A Alt 1**	**B Alt 2**	**A Alt 3**	**H Alt 4**	**C Alt 5**	**D Alt 6**	**E Alt 7**	**F Alt 8**	**G Alt 9**
New Operational Rules Controlling Maximum North Delta Intake Diversions											
Maximum Capacity of North Delta Intakes (1000 cfs)	-	0	15	15	6	9	3	15	9	9	0
Bypass Flows (% of SR at Freeport)	Jan–Dec	O	X	X	X	X	X	X	X	X	O
Delta Operational Rules Controlling Maximum Allowable CVP and SWP South Delta Exports											
Physical/Permitted Limit for CVP (4,600 cfs)	Jan–Dec	All									
Physical Limit for SWP (10,300 cfs)											
SWP Article 21 Delivery (when San Luis is Full)											
Available San Luis Reservoir Storage											
Seasonal CVP and SWP Delivery Pattern											
Permitted Limit for SWP (6,680 cfs plus 1/3 of San Joaquin River Dec 15–March 15)	Jan–Dec	X	O	O	O	O	X	O	O	O	X
Export/Inflow Ratio -S.Delta intakes: 65% Jul–Jan, 35%Feb–Jun		X	Xa	Xa	Xa	Xa	Xa	O	Xa	Xa	X
SJR Inflow/Export Ratio	Apr–May	X	O	Ob	O	Ob	X	O	Xc	Xc	Od
Reverse Old and Middle River Flows	Dec–Jun	X	X	Xe	X	Xe	X	O	Xf	Xf	X
Delta Operational Rules Controlling Minimum Required Delta Outflow											
Maximum Salinity (EC) for Delta Diversions	Jan–Dec	All									
Minimum Monthly Specified Outflow	Jan–Dec	X	X	X	X	X	X	X	X	Xg	X
Maximum Spring X2 Location	Feb–Jun	X	X	X	X	Xh	X	X	X	X	X
Maximum Fall X2 Location	Sep–Oct	X	O	X	O	Xh	X	X	X	X	X

Notes: “X” Draft BDCP Alternative has this operational rule. “O” Draft BDCP Alternative does not have this operational rule.
Key to letters following the “X” in above table:
a) In computing the E/I ratio for these scenarios, the SR inflow is considered to be downstream of the North Delta intakes, with the exception of Scenarios H2 and H4, for which SR inflow was assumed to be upstream of the proposed North Delta intakes.
b) Under these scenarios, a different strategy was applied to achieve similar objectives as the SJR I/E ratio.
c) SJR I/E ratio applies December - June and therefore would apply for five months longer than under the No Action Alternative.
d) SJR I/E ratio is applicable when the SJR flow at Vernalis is greater than 10,000 cfs.
e) More restrictive/protective than Scenario A.
f) More restrictive/protective than Scenario B.
g) More restrictive/protective than in the No Action Alternative; required Delta outflow is expressed as a percent of unimpaired flow.

h) For Alternative 4, maximum Spring X2 Location will be determined based on the results of the decision tree process for spring outflow. Maximum Fall X2 Location will also be determined by the decision tree process under Alternative 4.

Decision Tree Approach for Alternative 4

The BDCP Draft Environmental Impact Report/Environmental Impact Statement (DEIR/DEIS) leaves the key question of how the altered outflows would affect fish for Alternative 4 open. It proposes a ten-year research program that is to provide, upon completion of the new conveyance, "the fall and spring outflow criteria that are required to achieve the conservation objectives of the Draft BDCP for Delta Smelt and longfin smelt and to promote supply objectives of the Draft BDCP" (page 3-207). Six other species of concern (e.g. salmon) are not considered in the evaluation of spring and fall outflows, and the criteria for Delta Smelt may not be the same criteria as for longfin smelt. The proposed program would evaluate various combinations of operational spring and fall flows, some of which are expected to have adverse impacts on fish if restoration is not effective (e.g., DEIR/DEIS 11-1293, 11-1296, 11-1297). Appropriate questions to be answered by the studies and competing hypotheses are stated, but we found little basis for judging the program's adequacy and prospects. Missing elements include: (1) description of the scientific approach and monitoring to be used, (2) assessment of the range of year types (extremely wet to extremely dry) required for success, (3) consideration of which restored habitats will need to be functioning to test the hypothesis that additional habitat and improved food resources will benefit fish as much as would enhanced spring and fall outflows, (4) criteria that will be used to make the decision on which outflows will be required (e.g., a threshold population size that needs to be achieved), and (5) the outflows that will be required if the research program does not provide a definitive answer.

CHAPTER 4: APPROACH TO THE ENVIRONMENTAL ANALYSIS

I. Overall Assessment

The chapter does an adequate job of explaining the approach taken in the environmental analysis. However, the final assessment of net positive or no negative effect shown in the DEIR/DEIS is highly uncertain.

II. Scope

This chapter describes the approach to the environmental analysis. It provides a clear description of the difference between CEQA and NEPA baselines.

III. Quality of Analysis

Three geographic regions are considered in this chapter: upstream of the Delta, the legal Delta, and the State Water Project (SWP) and Central Valley Project (CVP) service areas. Areas downstream of the Delta (i.e., San Francisco Bay) were not included even though the National Research Council (NRC) scientific review specifically stated that this area should be included. Adequate justification for lack of consideration of impacts to San Francisco Bay was not provided in this chapter or elsewhere in the document, although there are potential impacts. For example, the expected reduction in sediment supply has the potential impacts of: 1) tidal marshes in the Bay could be less resilient to sea level rise, and 2) increased water clarity in the Bay could render it more responsive to nutrient inputs.

The chapter clarifies that the habitat restoration measures proposed are given only program level analysis for several reasons. Yet because of the uncertainty in location, implementation, and effectiveness of proposed restoration actions, the positive impacts of those actions that were considered as part of the DEIR/DEIS are highly uncertain.

CHAPTER 5: WATER SUPPLY

I. Overall Assessment

The lack of a comparative summary and an interpretation of results are the chapter's greatest weaknesses. The near-absence of a systematic comparison and discussion greatly reduces the ability of this analysis-filled chapter to contribute to thoughtful discussion and comparison of Alternatives. Since almost all of these water exports are to support the economic activities of agriculture and urban water needs, an explicit comparison of these economic impacts would provide information needed to evaluate the overall impact of the Alternatives.

There seems to be little difference between the 6 kcfs and 9 kcfs Alternatives. Deliveries for the 3 kcfs tunnel capacity are much less. However, much of the difference among Alternatives seems likely to be driven as much or more by operating and regulatory policies than by infrastructure capacities. This makes it imperative that project operating policies be explored as systematically as the range of physical capacities.

II. Scope

This chapter examines the changes in surface water operations and deliveries that would likely accompany each of the project Alternatives. A mercifully brief overview of California's water resources begins the chapter, followed by overviews of the SWP and CVP projects, other local projects in the Delta, and the regulatory and water rights setting. For each Alternative, results for Delta outflow, exports, project deliveries (North and South of the Delta), and major surface reservoir storage are presented. The modeling approach employed CALSIM II, with additional temperature and Delta flow and salinity modeling, for a particular climate change scenario (sea level rise and climate warming), averaging a wide range of potential climate warming scenarios for projected 2060 conditions. This analysis approach is of a fairly typical nature, with the exception of more seriously addressing climate and sea level changes.

The analysis of this highly complex problem for a wide range of Alternatives is inherently difficult and potentially confusing. The amount of model results presented is overwhelming, but there seems to be little effort to set these numbers to a story. It is a bit like an orchestra playing a symphony without a conductor and with the sheets of music sometimes shuffled. The notes are all there and mostly well-played individually, but the experience is less than satisfying.

An explicit comparison of the range of water deliveries for major user locations (project and non-project) over the range of wet and dry conditions would be valuable.

III. Quality of Analysis

The major analytical problem is the gap between CALSIM modeling of the system and actual operations. The SWP and CVP projects represented in CALSIM are only a small part of the water management decisions and impacts in this vast system. DWR and USBR modeling has improved considerably in recent decades, but remains CVP and SWP centric, largely ignoring or oversimplifying most water management decisions in California taken by local and regional governments and water users. This is adequate for simple SWP and CVP project analysis, but seems inadequate for statewide impact analysis of a system where the operations and decisions of local agencies have major consequences – conjunctive use, water conservation, market transfers, reuse, local reservoir operations, etc. Local agencies are likely to have more ability to adapt and interact with the CVP and SWP than is indicated in the modeling of this chapter.

To this problem, the continuing evolution of the CALSIM model and its many variants over time must be added. As shown by the results of the MBK modeling presented at an ISB meeting in January 2014, there will be differences in results reflecting both model evolution and different professional judgments in modeling complex systems – and these technical differences will likely be worth millions of dollars to different individual stakeholders.

A final problem is the continuing evolution of environmental and water regulations. Current regulations allow relatively little flexibility for operations of dual facilities (a point made by Mount et al. 2013). But, as demonstrated by changes in the last decade, these regulations can change dramatically over decadal periods. It seems a bit cheeky to prognosticate environmental regulations so far into the future.

Overall, there are both value and limits to our ability to estimate and compare the performance of Alternatives, for water supply and in many other regards. Many uncertainties are inherent in estimating and comparing the performance of diverse Alternatives for a complex and ever-changing system far into the future, or even today. We should not quest for certainty in such estimates and comparisons. Even as we try to narrow uncertainties, we should also organize Alternatives, institutions and decision-making to adapt as conditions change.

A simple illustration of the uncertainty inherent in this system is our inability to estimate the mean annual flow of the SR (a major driver of system performance). Over 84 years of record, the average SR flow is 22 million acre-ft (maf)/year, with the standard deviation of annual flow from this sample being about 10 maf/yr. This means that our estimate of the mean annual flow of California's largest river in terms of flow has a standard deviation of almost 1.1 maf, meaning that there is a 32% chance that the "true" SR mean flow is less than 20.9 maf/yr or above 23.1 maf/yr (means are normally distributed). (This reliability decreases if runoff is non-stationary.) Considering the value of water in California, this unavoidable uncertainty is easily worth hundreds of millions of dollars a year to water users.

Some lessons from the presented results seem to be that:

- The delivery reliability and difference between a 6 kcfs and 9 kcfs tunnel capacities are not large. However, 3 kcfs tunnel capacity delivers much less. (Figures 5-30 to 5-36). It would be useful to overlay annual exports for No Action, Existing Conditions, and Alternatives 3, 4, 5, 8, 9.
- Operating rules, and by extension regulatory framework, might make more difference in water deliveries than tunnel capacity.

Minor points:

- Page 67, what is WS-1 and WS-2?
- Where are Tables 5-4 through 5-9 results for Alternative 4?

IV. References Cited:

Mount, J.; W. Fleenor; B. Gray; B. Herbold; W. Kimmerer. (2013) *Panel Review of the Draft Bay Delta Conservation Plan*, report prepared for The Nature Conservancy and American Rivers, September 2013, 152 pp.

CHAPTER 6: SURFACE WATER

I. Overall Assessment

Overall the chapter is innocuous and uses canonical tools, and standard inference methods. The reason for selection of particular tools over select alternatives is not identified. Significant potential impacts are predicted for many Draft BDCP Alternatives under categories SW 4-6, and mitigation measures are proposed. It is not clear why a determination has not been made on the impacts of reverse flow conditions in Old and Middle Rivers under Draft BDCP Alternatives, although Chapter 6 lays out many of the impacts for each Alternative; a clarification is needed.

The existing summaries of Chapter 6 are limited to tabular entries in the Executive Summary and brief text in the Highlights Brochure. The table identifies nine surface-water impacts (pages ES-61 and ES-62), and the Highlights text offers four bulleted paragraphs (page 21 of Draft BDCP_highlights.pdf).

Like most of the DEIR/DEIS, Chapter 6 still lacks an informative summary of expected impacts of the No-Action and action Alternatives. It contains no up-front analysis that succinctly compares the Alternatives: No-Action vs. Actions, certain kinds of actions vs. other kinds of actions. It also offers no summary by impact, in contrast with Chapter 12 (Terrestrial Biology; pages 12-5 to 12-31). Chapter 6 still needs a cogent analysis of how the preferred Alternative (Alternative 4) compares to other Alternatives in terms of effects on, and effects of, surface water.

II. Scope

This chapter deals with environmental consequences of potential surface water changes from disturbances introduced by Draft BDCP conveyance and related facilities [CM1], operational facilities, conservation components [CM 2-22], and restored areas. The area examined is thought to be the most affected by SWP/CVP water supply operations and/or habitat restoration in the Delta and Suisun Marsh Restoration Opportunity Areas. Surface water in the Delta, upstream areas and in-export areas also will be affected by climate change and present/future projects. The changes affect the risks of floods, flow patterns, drainage, surface-ground water interactions, and streams. The construction of facilities as proposed by the Draft BDCP would occur in the SR/SJR basins, and the changes to SWP/CVP operations will affect the flow in the Delta and upstream. Surface water of many SJR and SR tributaries, as well as surrounding hydrologic basins, where conveyance features are located (pipes and canal systems) are unaffected. For each Draft BDCP Alternative, nine impacts are analyzed, and in some cases, mitigation measures are identified to reduce adverse impacts on run-off patterns, drainage, sedimentation, flooding, potential exposure, and risks to people or structures. The No-Action Alternative also is considered.

Surface hydraulics in the Draft BDCP area are complex, and are determined by circulation, transport, and mixing in Delta waters. The hydraulic network consists of over 700 miles of tidally influenced channels and sloughs, water supply facilities and about 18,000 diversions and 1,115 miles of (project and non-project) levees. The major forcing includes freshwater flow into the Delta, tidal input from the Pacific (as high as 600,000 cfs) and operation of water supply facilities. Sacramento River and Yolo bypass waters are the primary contributors, and move south and westward, followed by the SJR, which flows from the south. Pumping slows or reverses the flows that would naturally go north and west in the SJR (§5, §6 and §8). Operation of hydraulics structures has important tasks, including: elevating water

surfaces for diversions, preventing fish from entering canals, and changing of circulation patterns.

Amongst a myriad of impacts possible, the most critical ones have been identified for the analysis. For example, SWP/CVP reservoir storage and related changes to flood potential, peak monthly flow in SR and SJR, and reverse flows in Old and Middle river as a result of changing hydraulic characteristics are considered. The existing conditions are compared with the year 2060 scenarios of No-Action/No-project and Draft BDCP Alternatives with sea level rise and climate change (CEQA comparisons). Also compared are 2060 model conditions with Draft BDCP Alternatives that include climate change and No-Action Alternatives with climate change only (NEPA comparisons). The surface water resources have been evaluated at the project level when sufficient details are available; otherwise it resorts to programmatic level analysis.

The Effects Analysis (Ch.5 of the Draft BDCP) assumes reasonable thresholds to identify adverse effects under NEPA or a significant impact under CEQA, based on the number of months the reservoir is close to the flood storage capacity and peak monthly flows. Nine impacts (SW 1 to SW9) have been established and analyzed, and the results are placed in the framework of CEQA and NEPA effects.

III. Quality of Analysis

Commonplace modeling tools are used (CALSIM II together with ANN; DSM2 for water quality and particle tracking; CVHM hydrologic model), which are described in Appendix 5A. Also included therein are modeling assumptions, input parameters, and additional information. Impacts [SW 1-9] for each Alternative are addressed in a rigorous way. We offer the following comments for consideration:

- The chapter involves a comprehensive and laborious study, and has identified a wide range of impacts covering storage issues related to flood potential, peak monthly flows and flow reversals at critical locations. Related issues such as water quality, fish and aquatic resources and agricultural resources are addressed in other chapters. The inferences are almost entirely based on model outputs, but the reader is left to guess the uncertainties and how uncertainties affect these inferences, which are expressed in terms of ‘no impact’ and ‘less than significant impact’ etc. Uncertainties of complex models of the sort used here can be unacceptably high, model calibrations leave much to be desired (see Kimmerer et al. *San Francisco Estuary & Watershed Sc.*, Feb 2008), and inter-comparisons of different models are scarce (NRC 2012). Some recent references to model testing, if available, may help. CALSIM III has better capabilities for ground water-surface water interactions and disaggregation of demand units, and it would be useful to know whether the conclusions made would change if it is used.
- Flow-salinity relationships in Delta are evaluated using DSM2, which is linked to the neural network ANN to evaluate whether certain salinity requirements are met. The training of ANN is based on the current data, and the relationships so obtained may not be applicable to future scenarios with modified flow structures. In addition, DSM2 is a one-dimensional model and has inherent limitations in simulating open water areas, flow in bends, and small channels, as well as inlet/outlets. The Delta circulation patterns, which are strongly influenced by horizontal mixing, diversions, and freshwater input, therefore may not be adequately simulated by the modeling system used.

- Tidal energy coming from outside the Golden Gate is another limited resource in the development of habitat in the Delta and its larger estuary. A major effect of many of the proposed habitat restoration activities (as well as potential island failures in the future) is likely to be the changes in tidal amplitude and mixing. This will affect the suitability of certain characteristics for restoration. It will reduce mixing of inland and coastal waters and high-tide related flooding in the Delta. This aspect needs further consideration.
- Little is mentioned about the role of adaptive management, although development of hypotheses within the framework of complex Draft BDCP Alternatives would be difficult. Any information in this regard can be helpful.
- It is assumed that the Alternatives would modify the operations of SWP/CVP facilities but not the facilities owned and operated by other water rights holders. Thus, the surface waters of many SR and SJR tributaries are assumed to be unaffected (§6.3.1). Naturally, one would expect changes to the modus operandi of other owners in response to potential changes due to Draft BDCP Alternatives. Similarly, changes in flow regulations for environmental and water quality objectives into the distant future are not examined or discussed (and would be difficult to examine). No analysis or statement regarding such feedback is given.
- It was determined that estimating peak flows in a sub-monthly time step based on monthly flows of CALSIM II would not be reliable for flood risk analysis. Can HEC-RES-SIM or other modeling systems with higher temporal resolution be used in this regard?
- The list of communities subject to flooding does not include Bethel Island, a community of a few thousand on a fairly deeply subsided island (page 6-21).
- Chapter 6 considers how the Draft BDCP and its Alternatives may affect levees. It provides a lucid summary of levees as essential and vulnerable in flood control (pages 6-11 to 6-18). It also analyzes potential near-term damage to levees from construction of water-conveyance facilities (impact SW-7) and from creation of subtidal habitat (SW-8). Other parts of the DEIR/DEIS consider how Delta levees affect other resources. Levees are described as vital to water supplies under current conditions (pages 5-61 to 5-64; pages 3E-16 to 3E-18). By corollary, levees remain important under most of the action Alternatives, both for water supplies and for ecosystem restoration. A comprehensive levee chapter would bring these issues together. Its summary would compare Alternatives by their expectable effects on levee maintenance, not just during and soon after construction, but also on a 50-year timescale.

IV. References

National Research Council. (2012). *Sustainable Water and Environmental Management in the California Bay-Delta*. Washington, DC: The National Academies Press, 2012

Kimmerer, W.J. and M. L. Nobriga. 2008. Investigating Particle Transport and Fate in the Sacramento-San Joaquin Delta Using a Particle Tracking Model. San Francisco Estuary and Watershed Science. Vol. 6, Issue 1 (February), Article 4.

CHAPTER 7: GROUNDWATER

I. Overall Assessment

The most insightful aspect of this chapter is the likely effect of changes in Delta water deliveries on overdraft in the San Joaquin and Tulare basins. However, these results are not summarized and presented in a way that facilitates the thoughtful use of these results in comparing Alternatives. Peripheral canal Alternatives, where unlined, can significantly increase local groundwater levels in some areas, and decrease them in other areas (Figure 7-13). This also is examined with modeling results. Much of the results are based on modeling analysis.

The modeling analysis of these groundwater impacts itself seems largely adequate, although the awkward and partial summary of results in a comparative format seems to miss the opportunity to inform on major relevant impacts. Salinity results and impacts are not reported.

Absence of a comparative summary and interpretation of results are the chapter's greatest weaknesses. The near-absence of systematic comparison and discussion reduces the ability of this analysis-filled chapter to contribute to thoughtful discussion and comparison of Alternatives.

II. Scope

The chapter examines the effects of project Alternatives on groundwater in the Delta and in the southern Central Valley. Construction impacts on local groundwater are expected due to tunnel and canal construction and modeling results are presented on these issues.

The impacts of Alternatives on groundwater elevations within and south of the Delta are fairly well examined. However, there seems to be no comparison of the Alternatives in terms of likely changes in groundwater quality south of the Delta. The salinity of agricultural lands south of the Delta seems likely to be affected by the total salt load of water exported to this region. These salt loads are not presented or compared, even though modeling results appear to exist with the required outputs for this calculation. Other studies have found that changes in salt loads from changes in Delta operations and Alternatives could have considerable impact on agricultural land and profitability in the southern Central Valley (Medellin, et. at., 2008).

III. Quality of Analysis

The modeling is based on the USGS CVHM model. It would be useful to have a short discussion of uncertainty in this model's results, and a comparison with the state's C2VSIM model of Central Valley groundwater, which is also commonly employed. Both models are quite a bit better than their forebears, and for this purpose they seem likely to show qualitatively similar results.

Alternatives that reduce total water exports are likely to encourage additional overdraft in the large water project service areas. This could be substantial and almost equivalent to the amount of export reduction (Chu 2012). The DEIR/DEIS notes this, and has done modeling studies of it, but does not appear to present quantitative estimates of this effect – only the reduction in exports (Table 7-7). The analysis of differences in declines in groundwater levels in the southern Central Valley for different Alternatives should be more systematically and quantitatively presented.

The Alternatives are not expected to produce great long-term groundwater changes in the Delta. The largest effects seem likely to be localized from project construction.

An unlined canal (e.g., peripheral canal) might well have widespread waterlogging on lands near the right-of way.

Additional inundation of habitat, either permanent or seasonal, could increase groundwater seepage problems for local subsided islands. This seems likely to decline with time due to pore clogging. Experiences with ship channel dredging in the Delta might provide some lessons and data on this.

Specific Page Comments:

Page 7-3, line 38. "Groundwater modeling studies of the Sacramento Valley suggest that, on average, the flux of groundwater discharging to the rivers is approximately equal to the quantity of water that leaks from streams to recharge the aquifer system. The studies suggest that in average years, stream recharge and aquifer recharge are each about 800,000 AF per year (Glenn Colusa Irrigation District and the Natural Heritage Institute 2010)." This cannot possibly be, unless the basin is overdrafting. Most of the Sacramento Valley generally is in rough balance, so the recharge from streams and surface infiltration roughly equals aquifer pumping and groundwater discharge to rivers. Recent C2VSIM modeling for TNC shows quite different results, with much more stream loss to aquifers in recent decades to supply basing aquifer pumping.

Page 7-10. "TDS varies more widely in the Eastern San Joaquin Sub-basin, ranging between 50 and 3,520 mg/L. The high salinity of groundwater is attributed to poor-quality groundwater intrusion from the Delta caused by the decline of groundwater levels. This saline groundwater front has been particularly apparent in the Stockton area since the 1970s (San Joaquin County Flood Control and Water Conservation District 2008). Ongoing studies are attempting to identify the source or sources of chloride in groundwater along a line extending from Manteca to the northern side of Stockton. Initial concern was that long-term overdraft conditions in the eastern portion of the sub-basin were enabling more saline water from the Delta to migrate inland. Other possible sources include upward movement of deeper saline formation water and agricultural practices (U.S. Geological Survey 2006a)."

This seems misleading. The cited USGS report indicates that the salinity coming into groundwater is of marine origin, probably from the time when the surrounding sediments were formed. Given that sea water has not come nearly this far into the basin in recent geologic time, these are likely from ancient salt deposits, not tied to current or recent surface water management. The document later mentions (page 7-12) saline groundwater in shallow aquifers (<100 ft) under the central Delta. This should be mostly peat deposits laid down in the last 6,000 years. Where would these salts come from? The sea level has been rising for over 10,000 years and salt water has rarely, if ever, intruded into these aquifers during this time. Some saline drainage from agricultural operations might be possible.

Table 7-7. Long-Term State Water Project and Central Valley Project Deliveries to Hydrologic Regions Located South of the Delta (TAF/year)

Alternative	San Joaquin and Tulare Region	Central Coast Region	Southern California Hydrologic Region
Existing Conditions	2,964	47	1,647
No Action Alternative	2,519	40	1,484
Alternative 1	3,070	51	1,853
Alternative 2	2,846	49	1,711
Alternative 3	3,023	50	1,821

Alternative 4 Scenario H1	2,949	49	1,784
Alternative 4 Scenario H2	2,767	40	1,491
Alternative 4 Scenario H3	2,781	48	1,668
Alternative 4 Scenario H4	2,610	39	1,370
Alternative 5	2,709	45	1,613
Alternative 6	2,285	34	1,136
Alternative 7	2,272	36	1,162
Alternative 8	2,069	27	803
Alternative 9	2,529	43	1,410

IV. References

Chu, H. (2012). Groundwater Overdraft in California's Central Valley: Updated CALVIN Modeling Using Recent CVHM and C2VSIM Representations. Master's Thesis, Department of Civil and Environmental Engineering, University of California – Davis.

Medellin, J.; R. Howitt; and J. Lund. (2008). Economic Effects on Agriculture of Water Export Salinity South of the Sacramento-San Joaquin Delta, Appendix I to *Comparing Futures for the Sacramento-San Joaquin Delta*, Public Policy Institute of California, San Francisco, CA. August 2008

CHAPTER 8: WATER QUALITY

I. Overall Assessment

As noted for other chapters in the DEIR/DEIS, a concise and informative summary of the chapter would be extremely useful to readers and reviewers. This chapter, covering water quality impacts of the different Alternatives, is not very informative because of its reliance on a few modeling approaches, most notably CALSIM and DSR2, without an explanation of the limitations of these models. There is a noted lack of emphasis on validating model outputs with observational data, as well as a lack of any presentation or discussion of the uncertainties associated with the models. It is also unclear whether the models were run under likely scenarios of future conditions in the Delta (e.g., changing precipitation patterns, decreased snow pack, changes in timing and amount of freshwater delivery, higher temperatures, etc.).

II. Scope

This chapter covers the environmental setting and potential impacts of the different Draft BDCP Alternatives on water quality in the Delta as well as upstream of the Delta. It does not cover impacts downstream of the Delta, even though that was a specific recommendation of the National Research Council. Numerous constituents that can compromise water quality are covered, but it is difficult to tell which constituents are covered without reading the document in its entirety. For example, polycyclic aromatic hydrocarbons (PAHs) are covered in Section 8.2.3.14, but are not listed in Tables 8.1, 8.2, 8.3, 8.4, or 8.5. The reasons for including some constituents in those tables, but not others, are not clear. Temperature is specifically noted as being covered in Chapter 11, rather than in this chapter, but it seems sensible to include temperature impacts, or at least a summary of temperature impacts, in this chapter specifically dealing with water quality issues. This chapter does not cover ancillary effects of the Draft BDCP on water quality. Notably, an increase in water reliability may well result in altered agricultural practices, to include changes in crops, with associated changes in pesticide and fertilizer applications. That is a notable omission.

III. Quality of Analysis:

There is a general lack of knowledge displayed by the authors of this chapter about certain water quality constituents. This was most obvious in sections covering dioxins, PAHs, and emerging pollutants [more correctly called contaminants of emerging concern (CECs)]. Nomenclature and descriptions of these classes of compounds are often incorrect, sometimes egregiously so. For example, polychlorinated biphenyls (PCBs) are incorrectly classified as a subset of dioxins, and then statements are made about dioxins that are incorrectly extrapolated to PCBs. Moreover, the authors do not seem to know the difference between commercial PCB mixtures (e.g. Aroclor® 1254 or 1260) and individual PCB congeners (e.g. PCB-126), listing these disparate substances as PCB-1254, PCB-1260, and PCB-126. PAHs are specified as being derived from combustion products, ignoring the very large portion of PAHs coming into ecosystems as a result of spills and leakage of petroleum and its refined products, such as gasoline and diesel fuels. Very optimistic descriptions of CECs and their removal from wastewater by WWTPs are given, but no acknowledgment is made of many other CECs that are shown to be highly recalcitrant to such removals. Such demonstrations of unfamiliarity with the subjects covered do not engender confidence in the analysis.

For the discussion of carbon, it is recommended that carbon should be separated into its dissolved and particulate forms for consideration of water quality impacts and implications for Delta organisms. Dissolved organic carbon (DOC) is the form most likely to react with chloride and bromide and result in formation of disinfection by-products. Hence, emphasis was placed on DOC in this chapter. However, the chapter overlooks the role of carbon as a "master" ecosystem variable and the fact that dissolved and particulate forms cycle differently. DOC is mostly cycled through the microbial food web and is not typically transferred to upper trophic levels. In contrast, particulate organic carbon (POC) is comprised of microalgae as well as detritus from the watershed, marshes, and aquatic environment. POC is utilized as a "food source" for primary consumers, so this energy is transferred to higher trophic levels.

In addition to concerns about "lumping" carbon into a single parameter, carbon "quality" is not addressed. Carbon quality (e.g., sources, age, biochemical composition) is a key determinant of ecosystem processes such as food and energy. Carbon quality also influences organic matter respiration and is a contributor to water quality issues such as low dissolved oxygen (hypoxia) and methylation of mercury.

The treatment of nutrients is also lacking. The authors consider only ortho-phosphate and not total phosphorus (TP). In freshwater, TP is a much better predictor of algal productivity because so much P can be carried on and released from suspended sediments. There should be better linkage between the total suspended solids (TSS) section and the phosphorus section. If a regression had been done between TP and discharge rather than phosphate and discharge, it is very likely that a relationship would have been seen (page 8-214). From this chapter, it seems as though the upgrades to the Sacramento WWTP will not decrease phosphorus inputs, or if they would, it is not considered here. It is clear that for ammonia, the biggest change (and most significant improvement) is coming from the upgrade to the Sacramento Wastewater Treatment Plant. The analysis of ammonia, nitrate and phosphorus is entirely based on regulatory water quality standards with no attention paid to the biological consequences of more or less nitrogen, phosphorus, or altered N:P ratios. In the P discussion, the authors propose that phytoplankton production is related to light, not nutrients (page 8-214). With decreased sediment loads this may no longer be the case, or certainly it is not expected to be the case in the future as sediment loads (from past mining activity) continue to decrease. Hence, nutrient impacts on algae do need to be considered. In particular the potential of altered nutrient ratios to either encourage or reduce toxic algal blooms should have been considered. It is mentioned but discounted as unimportant in the SWP and CVP canals (pages 8-450 and 8-470).

As stated above, there is an over-reliance on model outputs, both to describe existing conditions as well as to project the effects of Alternatives on water quality constituents. There do not seem to be either a) attempts to compare model outputs for existing conditions to existing water quality data, or b) calls for monitoring of future conditions in order to inform adaptive management of Draft BDCP implementation. Because models will always be incorrect, such observational data are obviously required. Moreover, models were run for only certain constituents and not others; this needs to be clarified and the reasons for selective applications of models should be explained. Models should also be run under likely scenarios of future conditions in the Delta (e.g., changing precipitation patterns, decreased snow pack, changes in timing and amount of freshwater delivery, higher temperatures, etc.), and measures of uncertainty associated with the models should be presented and discussed with respect to their impacts on confidence in model outputs. It is also unclear whether the model runs considered the role of changing turbidity and light levels. Recent data indicate that concentrations of suspended

solids have been declining in the SR. This could impact ecological responses in the future (e.g., phytoplankton blooms). Turbidity will likely increase during the water conveyance construction phase, as well as during habitat restoration due to sediment disturbance. Following construction, concentrations of suspended solids (and light levels) may be quite different than they are today or over the timeframe 1992-2003, which was used for the model conditions. This could substantially alter water quality in the Delta and adjacent waters, again in ways that might not be predicted from model outputs.

There are concerns about remobilization of soils and sediments with legacy contaminants during construction of water conveyance structures and habitat restoration, which were not addressed in the DEIR/DEIS. Reservoirs of contaminants could be disturbed during excavation and construction projects. Some of these legacy contaminants could have detrimental impacts on organisms due to their tendency to bioaccumulate. Also, in regard to bioaccumulation, mercury and selenium appear to be the only constituents that were evaluated for their bioaccumulative properties. A range of organic contaminants (e.g., PAHs, dioxins, some endocrine disrupting compounds) also bioaccumulate, but this was not acknowledged or addressed in the DEIR/DEIS document.

The authors are rather cavalier about how they treat detection limits for analytes, especially when studies had high detection limits that are above water quality criteria. For example, on page 8-46 they report many non-detects of PCB-1254, -1260 etc. (sic), but do not report detection limits. It is later stated that SFEI data show detects, but detection limits were 0.01 pg/L, for individual PCB congeners, and that the SFEI detection limits are seven orders of magnitude lower than other studies. On the next page, they then report many non-detects (presumably with the higher detection limits in the range of 10 ng/L), and also list criteria for PCBs under various guidelines. Even though those criteria are far below the detection limits used, it is concluded that criteria have not been exceeded, presumably because PCBs were not detected.

On page 8-163 the following statement is made:

"Assessing pesticide-related effects is substantially challenged by: 1) limited available monitoring data in the Delta and other water bodies of the affected environment, and 2) a continually changing pesticide use market. Due to a number of factors, including historic pesticide use patterns and analytical capabilities, there is more data available for certain classes of pesticides, such as OP insecticides, than that for other classes of pesticides, including herbicides, fungicides, and insecticides such as pyrethroids and carbamates."

Despite the acknowledged difficulty in predicting water quality impacts of the project, caused by lack of observational field data, as far as we could see there was no call for enhanced monitoring of pesticides in the Delta. As stated above, reliance on model outputs without their validation by comparison to observational data is a flawed approach, especially for assessing the effects of water quality constituents with high levels of uncertainty surrounding them, such as pesticides. In the section on pesticides, it was also remarkable that there was no mention of recent investigations showing very significant synergism between carbamate and organophosphate insecticides, or research showing rapid acquisition of pesticide resistance in native copepod species in the Delta.

CHAPTER 9: GEOLOGY

I. Overall Assessment

Chapter 9 makes a murky case for its plausible conclusion that the proposed Draft BDCP actions would not add much to the existing geologic risk. The scientific basis for this conclusion is clouded by problems summarized in the sections below. Also mentioned in this review are potential scientific benefits that the chapter overlooks.

II. Scope

Geology affects the Delta as both resource and threat. Geology comes into play as a resource where including aquifers (Chapter 7), forming parent materials for agricultural soils (Chapters 10, 14), providing aggregate or natural gas (Chapter 26), and containing fossils (Chapter 27). The geologic threat mentioned most in the DEIR/DEIS is earthquake-induced failure of Delta levees (page 1A-8 to 1A-9; 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18).

Chapter 9, a "resource chapter," assesses geology as a threat to persons and property. The chapter enumerates, for impact assessment, the 16 threats listed in summary Table ES-9 as GEO-1 to GEO-16 (page 66-67). Most are tied to earthquakes. Five of the potential impacts would occur during construction of water-conveyance facilities under conservation measure CM-1 (GEO-1 to GEO-5); another six during operation of these facilities (GEO-6 to GEO-12); and the remainder in association with habitat restoration efforts (GEO-13 to GEO-16).

As summarized in Table ES-9, the CEQA impacts are "less than significant" both before and after mitigation for all 16 threats under all the action Alternatives. The table rates the No Action Alternative as having three potential impacts that are "beneficial."

III. Quality of Analysis

<u>Narrow assessment of levee failure</u>

Although Delta levees figure abundantly in the DEIR/DEIS as a Delta resource, no resource chapter addresses impacts to levees comprehensively. Delta levees are presented as vital to water supplies (pages 3E-16 to 3E-18, 4-9, 5-61 to 5-64, 29-19 to 29-20; Appendix 5B) and to flood control (pages 6-11 to 6-18), and the threat of levee failure is cited as a reason the proposed conveyance facilities are needed (pages 2-3, 31-5). In addition, Chapter 4 of the Draft BDCP describes levee improvements to be carried out as part of several of the proposed conservation measures. Yet formal assessment of levee-related impacts appears limited to Chapter 6 (Surface Water) and Chapter 9 (Geology). These chapters ask whether the construction and operation under the various Action Alternatives would increase chances of levee failures from floods and earthquakes. The Geology chapter limits its consideration of levees to the immediate vicinity of facilities at or near the ground surface. No chapter considers two broader effects: how Delta levee failures would affect water operations under the various Alternatives (summarized pages 29-19 to 29-20); and how the various Alternatives would affect the economics of maintaining Delta levees.

A comprehensive assessment of levee-related impacts would treat them more broadly. It would ask how levee failures would affect each Alternative in terms of water supplies and ecosystem health. It would also explore how each Alternative may affect incentives and funding for levee maintenance and it would evaluate each Alternative in light of the climate change impacts (sea-level rise, extreme floods) discussed on pages 29-19 and 29-20. The broadened

assessment would consider the No-Action and Action Alternatives in light of recent reports about Delta levees. These include discussions of hazards to Delta levees (Mount and Twiss, 2005; URS Corporation and Jack R. Benjamin & Associates Inc., 2008; Brooks et al., 2012) and of strategies for risk reduction (Suddeth et al., 2010; URS Corporation and Jack R. Benjamin & Associates Inc., 2011; Bates and Lund, 2013)

Debatable choices about levels of significance

The DEIR/DEIS estimates that the Action Alternatives would have "less than significant" impacts on the potential for death, injury, or property loss from earthquakes and their effects. This assessment applies both before and after mitigation according to the summary table (pages ES-66 and ES-67). Safeguards built into engineering design and construction practices are expected to prevent "an increased likelihood of loss of property, personal injury or death of individuals (example, pages 9-53 to 9-54).

Chapter 9 does not appear to factor a background threat of levee failure into these reasonable conclusions. The chapter summarizes this threat in section 9.3.3.1.1 (pages 9-49 to 9-50), and the threat looms in other parts of the DEIR/DEIS as well (pages 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18). In a further instance, a water-supply assessment cites the threat of earthquake-induced levee failures that could flood as many as twenty Delta islands at once (page 5B-12). The impact assessments in Chapter 9 do not appear to consider Action Alternatives in combination with levee failures unrelated to the actions. Would these combinations result in any increased likelihood of losses to persons or property?

The tabular summary of potential impacts on pages ES-66 and ES-67 can be misread as implying that benefits assigned to the No-Action Alternative do not extend to the Action Alternatives. The benefits are derived from "ongoing plans, policies, and programs" that seem largely independent of the Draft BDCP (pages 9-50 to 9-51).

Indefinite plan for assessing liquefaction hazards

Liquefaction, in which pore-water pressure lowers the strength of granular material, is the main process by which earthquakes are likely to cause levee failure in the Sacramento - San Joaquin Delta (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The liquefiable materials may be within a levee, beneath the levee, or both. The modes of resulting damage may include sliding, settlement, cracking, and groundwater eruption. Unlike localized breaches in the Delta's written history, the failures associated with future liquefaction may extend along levees for hundreds of meters. These concerns provide ample justification for the sections in Chapter 9 that accordingly consider liquefaction hazards to Delta levees.

Chapter 9 provides little information, however, about the basis for its liquefaction analyses. Such analyses commonly begin with borehole data like those in Figure 9-4. The chapter states that the analyses will use "available soil data from the [Conceptual Engineering Reports]" of proposed Draft BDCP conveyance alignments (page 9-46). Those reports are listed on pages 9-1 and 9-2, but they do not appear to be available online—a status that in today's world is effectively equivalent to not existing at all.

Subsequent steps are summarized in a one-paragraph statement of approach (page 9-70). The approach appears to follow the so-called "simplified procedure" that engineers routinely use in liquefaction-hazard assessment. This procedure originated over 40 years ago (Seed and Idriss, 1971) and was updated in the last decade (Idriss and Boulanger, 2008).

Uncertainty not mentioned in Chapter 9 surrounds current implementation of the "simplified procedure" of Seed and Idriss (1971). Competing curves relate the occurrence or

non-occurrence of liquefaction to material properties and ground motions (Idriss and Boulanger, 2010; Seed, 2010). The matter is under study by a National Research Council committee (http://www8.nationalacademies.org/cp/projectview.aspx?key=49573).

Even if this uncertainty is set aside, Chapter 9 appears deficient in details on how liquefaction-hazard assessment under the Draft BDCP will be carried out. Such details appear to await "final facility designs" in which "site-specific geotechnical and groundwater investigations would be conducted to identify and characterize the vertical (depth) and horizontal (spatial) extents of liquefiable soil" (page 9-70).

A reviewer may reasonably wonder whether the liquefaction part of the impact assessment is to be carried out at the project level or the program level. An overview on page 3-22 states that project-level assessments are provided for conveyance facilities (CM1), while program-level assessments are made for other actions. Whatever the case for liquefaction, its assessment seems part of a mitigation measure for preventing any increase in the "likelihood of loss of property, personal injury or death of individuals" (example, page 9-53).

Neglect of other clues to liquefaction risk

Comprehensive assessment of liquefaction risk to levees in the Delta and the Suisun Marsh was central to the Delta Risk Management Strategy (DRMS) study discussed in the next section (page 28). The assessment was based in part on application of the "simplified procedure" of Seed and Idriss (1971) to borehole data from Delta levees. The assessment also took account of the steepness of levee banks. The products include maps of the Delta and Suisun Marsh that show the distribution of potentially liquefiable sand beneath levees, the presence of sand within levees, and the levee-failure vulnerability in three generalized categories (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Figs. 6-35, 6-36, and 6-37). The sand beneath levees was found most widely liquefiable in northern and southeastern parts of the Delta, areas that include proposed Draft BDCP conveyance facilities.

Chapter 9 appears to say nothing about these findings. As its leading example of liquefaction-hazard mapping the chapter instead uses findings from the year 2000 (page 9-22, Fig. 9-6). These findings were not built into DRMS because "all aspects of that analysis, the seismic hazard model and, the fragility analysis are out of date" and because several principals in the 2000 work advised against using it (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. B, page 6-1). The depiction of hazard in Figure 9-6 contrasts with that by the DRMS study. For instance, Figure 9-6 of Chapter 9 shows all Sherman Island levees as having high potential for damage from liquefaction, while DRMS Figure 6-37c assigns a majority of Sherman Island's levees to the lowest of three categories of vulnerability to earthquakes (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

The liquefaction map in Figure 9-6 also neglects a common approach to sketching liquefaction hazard on a regional scale. As illustrated by damage to railroad bridges by the 1964 Alaska earthquake (McCulloch and Bonilla, 1970), the abundance and severity of liquefaction commonly varies with the age and depositional environment of geologic materials. Geologic maps may thus be transformed into liquefaction-susceptibility maps (Tinsley et al., 1985; Holzer et al., 2009).

In the Delta, mapped geologic materials of greatest concern for liquefaction are the sand and silt that accumulated in stream channels during recent millennia. Some of these form ribbons of potentially liquefiable material that extend beneath Delta levees. Many such ribbons have been delineated from historical maps and from interpretation of aerial photographs (Atwater, 1982; Whipple et al., 2012).

Also of potential concern is wind-deposited sand that extends into most of the Contra Costa County part of the Delta. Chapter 9 mentions these geologic materials (pages 9-4 to 9-8) and identifies them as "liquefiable during major earthquakes" (page 9-69).

Reliance on a superseded assessment of seismic hazards

Chapter 9 makes abundant use of a draft report from the Delta Risk Management Strategy (DRMS) study cited above. This study included a comprehensive assessment of seismic risk to levees of the Delta and Suisun Marsh. The risk assessment study runs 270 pages as section 6 of the final report issued in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A 2007 draft (URS Corporation and Jack R. Benjamin & Associates Inc., 2007), underwent abundant revision after critical review (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. A, B). Chapter 9 uses only the 2007 draft, which it typically calls "the seismic analysis" and cites as "California Department of Water Resources (2007a) and as "DWR (2007a)." Among text and tables in Chapter 9 are about 85 such citations in all.

This situation leaves the reader wondering whether use of the final 2008 report, instead of the 2007 draft, would change the impact assessment in Chapter 9. A spot check of Tables 9-7 and 9-11 shows minor differences with entries in the corresponding tables in the 2008 DRMS report (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Tables 6-1 and 6-5, respectively). A fuller assessment of the impact of the obsolete DRMS version is beyond the scope of this review.

Chapter 9 recently went out of date in its citations about probabilistic estimates of earthquake shaking in California. The earthquake probabilities cited on page 9-10 were estimated more than a decade ago by the 2003 Working Group on California Earthquake Probabilities. The 2007 group released an updated assessment as Uniform California Earthquake Rupture Forecast 2 (Field et al., 2009). Table 9-12 (page 9-21) effectively cites this assessment by referencing the related 2008 version of the USGS national seismic hazard maps. But a rigorously up-to-date version of Chapter 9 would have mentioned a further iteration, UNCERF3, that was released in part in November 2013 (Field et al., 2013), in preparation for the 2014 national update.

Carelessness with assertions and references

"These organic soils [the peat of tule marshes] formed from accumulated detritus of the tules and other vegetation." (page 9-3)—Tidal marshes and tidal swamps aggrade by trapping sediment that tides bring in and by retaining organic matter that the wetland plants produce on site. The retained organic matter includes roots and below-ground stems (rhizomes) that the plants inject into wetland soils (Nyman et al., 2006; Mudd et al., 2009; Kirwan et al., 2010; Miller and Fujii, 2010; Takekawa et al., 2013, pages 10-11).

"It was necessary to use different sources to compile the geologic map" (page 9-3)—A new source not mentioned is mapping by Sowers et al. (2013). An example of this mapping, along the Sacramento River south of Sacramento, was presented as a poster at the 2010 Bay Delta Science Conference.

"The text descriptions [of geologic map units] are taken directly (i.e., verbatim) from the work done by Graymer et al. (2002) because this work...provides the most recent and relevant general descriptions of the geologic units that occur in the Plan Area" (page 9-3)— This compiler's choice is a debatable one. The Delta makes up less than 1/6 of the map area of Graymer et al. (2002), and barely 1/3 of the Delta lies within that map area. A Graymer map name adopted on page 9-4, "Delta mud deposits," poorly describes deposits that are dominated by peat in the central Delta. The associated description of Delta peatland as

lowered by "compaction and deflation" misrepresents subsidence that owes more to decomposition (pages 10-11 to 10-12) (Deverel and Leighton, 2010).

"This correlation [of geologic names used on two different maps] is only an approximation provided by the chapter author to aid the reader. It is not a scientific or peer-reviewed analysis." (pages 9-4, 9-6, 9-7, 9-8)—Disappointing

"In 1935 the University of California Agricultural Experiment Station mapped the surface soils" (page 9-4)—The work perhaps alluded to here, without citation, is the classic Delta-wide soil survey by Cosby (1941).

"The Delta and Suisun Marsh are in...one of the most seismically active areas in the United States" (page 9-10)—Seems at odds with another statement on the same page: "...the San Francisco Bay Area and Delta region have generally experienced low-level seismicity since 1800."

"…tsunami inundation area on the shores of the Sacramento River" (page 9-25)—The statement apparently refers to Carquinez Strait.

"Peak acceleration response at a period of zero seconds or PGA is also widely used to characterize the level of ground motion." (page 9-45)—Peak ground acceleration is conventionally defined as "maximum acceleration experienced by the particle during the course of the earthquake motion" without respect to frequency (http://eqint.cr.usgs.gov/parm.php).

"With respect to the hazard of a seiche, the existing water bodies in the Delta and Suisun Marsh tend to be wide and shallow." (page 9-50)—Disregards channels

"Levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (page 9-50, reiterated page 27-22)—This unreferenced statement appears to be taken verbatim from a DRMS report; it appears on page 6-37 of the final seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A more nuanced statement would cite this report's Figure 6-35 as evidence that liquefiable foundations, identified through geotechnical borings, are most common in northern and southeastern parts of the Delta. In a further nuance worth mentioning: for the 1906 San Francisco Earthquake, "calculations indicate that small to moderate damage would have occurred if the levees were at today's configuration during the 1906 event" (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, page 6-36).

Chapter 9 cites large reports without pointing the reader to specific pages or figures within them. A more rigorous assessment would cite by chapter and verse.

The reference list for Chapter 9 excludes not just the final DRMS reports (URS Corporation and Jack R. Benjamin & Associates Inc., 2008; URS Corporation and Jack R. Benjamin & Associates Inc., 2011) but also a prominent update on procedures for assessing liquefaction hazards (Idriss and Boulanger, 2008) and an authoritative review of Delta subsidence (Deverel and Leighton, 2010).

Lack of summary

Like most of the DEIR/DEIS, Chapter 9 lacks an informative summary of expected impacts. The chapter's existing summaries are elsewhere, and they are limited to tabular entries in the Executive Summary and to watered-down text in the Highlights Brochure.

The chapter needs a summary, pitched to specialists but accessible to others, that would build on the entries on pages ES-66 and ES-67, and on the text in Highlights pages 26 and 27.

The summary would make clearer how the various Alternatives, including the No-Action Alternative, compare with one another in terms of effects on geology as a threat (and perhaps also as a scientific resource). Included would be an analysis of how the preferred CEQA Alternative compares with the No Action Alternative.

The Executive Summary of the DEIR/DEIS could tabulate the Chapter 9 impacts more clearly. Each of the three groups of potential impacts shares identical text that could be gathered in a header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

Benefits overlooked

A CEQA guideline recommends assessing impacts that would "Directly or indirectly destroy...a unique geologic feature." Another CEQA guideline asks, "Does the project have the potential...to eliminate important examples of the major periods of California history or prehistory?" (http://ceres.ca.gov/ceqa/docs/Adopted_and_Transmitted_Text_of_SB97_CEQA_Guidelines_Amendments.pdf)

Chapter 9 might thus consider, as incidental benefits of Draft BDCP Action Alternatives, geologic discoveries along routes of proposed tunnels and canals. Such discoveries may provide long-term context for 21st-century questions about climate change and ecosystem restoration (Malamud-Roam et al., 2006; Canuel et al., 2009). Precedents include incidental use of bridge-foundation borings as guides to sea levels and marsh accretion at San Francisco Bay (Trask and Rolston, 1951; Atwater et al., 1977).

Borings for proposed Draft BDCP tunnels are already providing insights into prehistoric volcanic eruptions. The borings have sampled volcanic ash layers that erupted about 400,000 years ago near Bend, Oregon, and about 600,000 years ago near Mount Lassen, California (Maier et al., 2013). Widespread volcanic-ash layers are important to geologists not only as signs of catastrophic hazards but also as unique tools for assigning, to the same instant in geologic time, climatic and tectonic events in widely separated places (Sarna-Wojcicki et al., 1983; Sarna-Wojcicki et al., 1985). Such scientific use of Draft BDCP geology would complement the engineering application of the findings in Figure 9-4.

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CHAPTER 10: SOILS

I. Overall Assessment

Chapter 10 concludes that the proposed Draft BDCP actions would cause significant harm to farmland soils by burying some beneath construction spoil and by inundating others in habitat-restoration areas. The chapter also determines that the soils pose little threat to the Draft BDCP actions. These plausible findings are undercut by inadequate summaries, missing references, and minor inaccuracies.

II. Scope

Chapter 10 treats soils both as agricultural resources and as construction hazards. In five of the nine soil impacts considered, the question is how an action (or inaction) will affect soils by means of erosion or decomposition. In the four other impacts, the soils pose potential hazards to people and facilities.

With four exceptions, the CEQA impacts for all options are termed "less than significant" both before and after mitigation (pages ES-67 to ES-68). In two of the exceptions, the No-Action Alternative is called "beneficial" because of non-BDCP efforts to arrest subsidence from decomposition of peat (SOILS-3, SOILS-8). In the other exceptions, topsoil is lost to decomposition under the No Action Alternative, to burial under spoils from construction of conveyance facilities, and to inundation from habitat restoration (SOILS-2, SOILS-7).

Not included among impacts assessed is soil loss from unintended flooding. Lasting losses may be limited to scour ponds and their aprons if levee breaches are repaired. On islands left permanently flooded the losses are of course greater.

III. Quality of Analysis

<u>Inadequate summaries</u>

Like most of the DEIR/DEIS, Chapter 10 needs to begin with an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and brief text in the Highlights Brochure. The table enumerates nine soil-related impacts (pages ES-67 and ES-68), and the Highlights Brochure describes soil losses as a Draft BDCP impact (page 28 of Draft BDCP_highlights.pdf).

A useful summary, placed at the beginning of Chapter 10, would quantify losses and relate them to the No-Action and Action Alternatives. For instance, a table similar to the one on page 39 of the Highlights Brochure would itemize losses of agricultural soil from burial by tunnel waste, excavation of canals, and intentional breaching of levees. The table and associated text would analyze Action Alternatives by broad category, as done effectively in the Chapter 12 summary.

The summary would make clear, quantitatively, how the various options, including the No-Action Alternative, stack up in terms of effects on and of the soils. The summary might show, for instance, that the tunnel Alternatives would cause fewer losses to certain kinds of agriculturally important soils than would the canal Alternatives.

The existing Highlights text conflates landforms and soils in a confusing fashion. This text should conform more nearly to the Chapter text, which creates no such confusion (pages 10-3 to 10-6).

The Executive Summary of the DEIR/DEIS could tabulate the Chapter 10 impacts more clearly (pages ES-67 and ES-68). The impacts form two groups: SOILS-1 to SOILS-5 on

conservation measure CM1, SOILS-6 to SOILS-9 on other conservation measures. Each of the two groups of potential impacts shares similar or identical text that could be gathered in a header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

The tabular summary on pages ES-67 and ES-68 could distinguish more clearly between No Action and Action Alternatives in terms of No-Action impacts that also apply to proposed BDCP actions. Under impacts on subsidence, the summary presents the No Action Alternative as beneficial because of subsidence-reversal projects independent of the proposed BDCP actions, without applying this benefit also to the proposed BDCP actions. Similarly, "significant" soil loss, under the No Action Alternative, if caused chiefly by decomposition of peat, would seem to extend to the proposed BDCP actions.

References missing

Page 10-2, lines 35-38—This summary of geological history, referenced to a report from 1950, exaggerates the roles of Carquinez Strait and inorganic sediment in building the historical channels and tidal wetlands of the Delta. Chapter 9 cites additional, newer references that could help here.

Page 10-3, lines 20-21—Could also cite the classic survey by Cosby (1941).

Page 10-4, line 4—According to this generalization from 1950, peat with many rhizomes of *Phragmites australis* [the current species name for this reed] underlies peat with many rhizomes of *Schoenoplectus acutus* and *S. californicus* [the current names for the main bulrushes]. Subsequent work has not reproduced this finding (Atwater, 1982; Drexler, 2011).

Page 10-4, footnote 1—The most up-to-date, reliable source on peat thickness is Deverel and Leighton (Deverel and Leighton, 2010, page 8). The 2007 California Department of Water Resources reference cited in the footnote is an obsolete draft of a report finalized in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

Page 10-10, lines 16-17—Prefer Galloway et al. (1999) as comprehensive and technically sound, as well as written and illustrated for broad audiences

Page 10-11, lines 6-21—A standard reference not cited: Thompson (1957).

Page 10-11, line 24—Update to Deverel and Leighton (2010).

Minor points:

Page 10-2, lines 2-3 and 31-33—Distinguish between "soils" in the agricultural sense and "soils" as used by engineers.

Page 10-3, line 33—This summary could identify the soils of modern tidal wetlands and compare them to the diked and drained soils of former tidal wetlands. Likewise for the summary of Suisun Marsh soils on page 10-4, lines 20-22.

Page 10-5, line 16—The heading "Valley Fill" is potentially confusing because it brings to mind Sacramento Valley, San Joaquin Valley, Central Valley.

Page 10-11, line 1—Now *Schoenoplectus acutus* and *S. californicus.*

Page 10-11, line 5—Is this peat depth residual (after subsidence) or original (ca. 1850)?

Page 10-12, line 42—The current rates of subsidence vary with substrate. The rates are probably zero in the large part of Jersey Island where Pleistocene dune sand is exposed at the ground surface. This is an important point that bears on restoration opportunities in other parts of the Delta where mineral soils have already been exhumed; these areas can't subside further by decomposition of peat. This issue reappears on page 10-26, beginning on line 32, with a section that describes subsidence from decomposition of organic soils as continuing "to varying degrees." The section does not describe geographic differences. A fuller description would identify the west-central Delta as the main area where mineral soils are not widely exposed.

Page 10-13, line 17—This section could be expanded to discuss consequences of arresting or reversing subsidence. A supporting reference: Miller and Fujii (2010). The discussion would help anticipate the benefit identified on page 10-26, line 40.

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CHAPTER 11: FISH AND AQUATIC RESOURCES

I. Overall Assessment

Overall the DEIR/DEIS could demonstrate a more balanced approach by fully discussing results from an ecosystem perspective (to add to the species-by-species discussions), fully embracing uncertainty and discussing it uniformly while distinguishing knowns from unknowns, and explicitly stating assumptions and differentiating conclusions from hypotheses. The detailed piece-by-piece and part-by-part treatment of CMs and species, although perhaps necessary, dilutes the merit of the overarching ecosystem perspective of the intent of this plan. Success will depend on a fully functioning system and analyses that incorporate integration across species, within a species, and across regions. Adaptive management will require a well-planned and comprehensive research and monitoring program that will target causality and test Draft BDCP hypotheses.

Our specific concerns with this chapter of the DEIR/DEIS include: (1) positive benefits of habitat restoration are highly uncertain, and if not realized, will invalidate the final conclusion of no net negative effect; (2) further analysis of effects of flow on entrainment is needed; (3) the decision-tree process is not adequately described; (4) interactions and synergies among species and the potential impacts on other ecologically important species are not adequately considered; (5) the qualitative nature of the effects analysis makes results more aligned with 'hypotheses' rather than 'conclusions' or 'predictions'; (6) full life cycles are not adequately considered; (7) a more complete description of adaptive management is needed; and (8) uncertainty in the conclusions is not adequately acknowledged throughout the DEIR/DEIS.

II. Scope

This extensive and comprehensive chapter evaluates impacts of construction, maintenance, and operation of each of the Alternatives of Conservation Measure (CM) 1 and many of the other conservation measures on fish and other aquatic resources. Impacts on 20 fish species are evaluated. Eleven <u>covered</u> fish species that are federally threatened or endangered (Delta Smelt, longfin smelt, Sacramento splittail, fall-, winter-, and spring-run Chinook salmon, steelhead, green sturgeon, white sturgeon, Pacific lamprey, and river lamprey) are discussed separately for each of the Alternatives and most CMs, often for multiple fish life stages. The nine <u>non-covered</u> species that are California Species of Concern or of recreational and/or commercial importance (striped bass, American shad, threadfin shad, largemouth bass, Sacramento tule perch, Sacramento perch, Sacramento-San Joaquin roach, hardhead, and California bay shrimp) are discussed collectively. In addition, impacts of CM 1 and Alternatives on other cold-water habitat species in upstream reservoirs are evaluated.

As stated in Chapter 11, the actual effects of the actions are dependent on a clear understanding of Chapter 5 (the Effects Analysis) in the Draft BDCP. For example, "The methods used to analyze impacts to covered and non-covered fish and aquatic species in Chapter 11 rely on the models and data included in the Effects Analysis…An understanding of the Effects Analysis will help inform a review of Chapter 11. In some instances, the description of fish species life stage timing and distribution varies between the Effects Analysis and DEIR/DEIS. These differences are in the process of being updated to match one another…" (page 11-2).

Sixteen of the 22 CMs are dealt with in detail for each of the covered species. These can be summarized as impacts as a result of the construction, maintenance and operations of the new

water conveyance systems (CM 1), impacts from habitat restoration efforts, (principally CM 2 and CM 4 but also CM 5, CM 6, CM 7 and CM 10) and those individual activities (CM 12 – CM 19 and CM 21) that are designed to "reduce the direct and indirect adverse effects of other stressors on covered species." The latter include reductions in predators, illegal harvest, invasive vegetation, enhancement of hatcheries for some species, installation of nonphysical fish barriers, and improved oxygen conditions in the Stockton Deepwater Fish Channel.

In essence, a simplified summary of the primary projected impacts of the DEIR/DEIS is:

1) The construction, maintenance and operation of a new water conveyance system could change downstream flow rates and could have negative impacts on some species. However, the new conveyance system will allow additional flexibility in flow control that may improve resilience to climate change and may reduce fish entrainment losses by shifting intake usage between North and South intakes based on fish abundances in the area.
2) Habitat restoration, including flood plain inundation, may increase physical habitat area and food production for covered species via increased phytoplankton production.
3) Targeted activities will attempt to reduce predators, control invasive species, reduce illegal harvest, and be beneficial to certain species in various ways.

There were also several mitigation measures proposed to minimize the biological effects of construction and maintenance activities. In many cases it is argued that any negative impacts caused by changes in outflow would be fully compensated for by other conservations measures, principally habitat restoration.

III. Quality of Analysis

Effectiveness of Habitat Restoration

A fundamental component of the overall program is the success of comprehensive habitat restoration and connectivity. In essence it is argued that the positive benefits of habitat restoration and (aquatic related) conservation measures CM2 – CM22 will counterbalance any negative impacts that might be triggered by CM1 through changes in flows and water diversions.

It is a reasonable hypothesis that each Conservation Measure CM 2 – CM 22 might be beneficial to one or more covered species. Yet the degree of uncertainty does not rule out that the effects will be zero or negative. The uncertainty in the level of success of these measures makes it difficult to make the case scientifically that these benefits will counterbalance negative impacts elsewhere. If proposed habitat restoration actions are not implemented in a timely fashion or are not as effective as assumed in the DEIR/DEIS, then the positive impacts of those actions would no longer be present, and the final assessment of a net positive or no net negative effect would not be valid. A key uncertainty that has a profound impact on the assessment of impacts is the extent, timeliness, and effectiveness of the protection and restoration actions, particularly restoration of tidal marshes and floodplains (including the Yolo Bypass).

Extent: Specific sites for restoration activities have not been determined, nor has their ability to pass environmental review requirements been assessed. If willing land-sellers are not found or if environmental problems are identified (e.g., excess methyl mercury production), then

those preservation and restoration actions and the positive benefits attributed specifically to them in the impact analysis would not occur. Likewise, the analysis of hydrodynamic changes with new intakes and habitat restoration are central to evaluation of the effects on fishes. Yet the hydrodynamic analysis is based on one possible configuration of habitat restoration, and if that is not the final configuration, the results of the hydrodynamic analysis could change. The sensitivity of conclusions to the configuration of habitat restoration should be evaluated in the DEIR/DEIS.

Timeliness: Construction and flow operations may have impacts immediately, whereas the restoration impacts and benefits may lag a decade or more after construction. Often it is claimed that the negative impacts in one area (e.g., flow changes on covered species) can be compensated for by habitat restoration. Analyses suggesting this result are often based on the implicit assumption that the new habitats are 100 % effective and fully functional ecosystems that are tightly integrated physically and biologically with the rest of the Delta. The literature strongly suggests, however, that there are significant time lags between construction of a new habitat and its full functionality. This means that the benefits of habitat restoration may not occur for a long time and that the benefits may be too late for some species if negative impacts come first. These time lags were not fully considered in the DEIR/DEIS. The effect of time lags on overall conclusions should be evaluated in the DEIR/DEIS. Alternative scenarios should be considered in which habitat restoration begins sooner or is phased in to maximize the benefits (e.g., by starting with habitats that will have the largest impacts). The priority of habitats to be restored is not indicated, so it is not clear if the most critical habitats will be first on the list.

Effectiveness: Even if all acres are acquired and restoration actions are taken in a timely manner, whether those actions will deliver the anticipated benefits or not is also uncertain. For example, the analysis regarding habitat restoration assumes there will be increases in phytoplankton production and that these increases will be transferred up the food web to covered species. This largely ignores an equally likely result that the added biomass of phytoplankton will be consumed by clams, which have had substantial effects on phytoplankton abundance and species composition throughout the Delta. Moreover, new zooplankton could also be consumed by other fishes. Whether or not any increases in primary production will be transferred to zooplankton and on to covered species that may reside in the restored area or outside of it is largely unknown.

Based on a thorough and credible review of the scientific literature and extensive experience in the ecosystem, Mount et al. (2013) question whether the tidal marsh and floodplain restorations will deliver the food subsidies anticipated to Delta and longfin smelt. Their concerns seem justified. Increase in habitat area is not necessarily a metric for increases in habitat quality or functionality. Although the Adaptive Management Team is tasked with assessing the effectiveness of the restoration actions, there is no description of management actions that will be considered if the positive effects are not observed. Hence we are not able to determine if those actions could possibly compensate for the negative impacts identified.

Impacts of Flow Operations

The main impacts of new flow operations (CM 1) on fishes are to: 1) allow flexibility to shift entrainment from the South Delta intakes to the new North Delta intakes, and 2) change

flow rates and other associated conditions (e.g. water temperature and turbidity) downstream from the North intakes.

Entrainment: It is suggested that overall entrainment of fishes may be reduced by increasing flexibility to re-routing flows into the North or South intakes on the basis of fish distributions in the area as well as the use of improved intake structures at the North intakes (new screening processes and state-of-the-art positive barrier fish screens). However, one credible analysis of the modeled flow regimes (Mount et al. 2013) points out that, although significant uncertainties are incorporated into the CALSIM modeling, they are not given adequate consideration when statements about effects are made. In addition, both Mount et al. (2013) and a credible review by MBK Engineers (presentation at January 2014 ISB meeting) question whether the system can be operated as simulated in the CALSIM modeling and hence whether the predicted reductions in entrainment will actually occur. Reducing entrainment by shifting intakes to those areas with fewer fish requires good estimates of fish concentrations in the immediate area. Therefore, estimates of entrainment should be bracketed based on model uncertainties.

Flow rates: The impact of altered outflow cannot be adequately assessed with the information given because the operational flows are not yet determined for Alternative 4. Some of the possible flow regimes have negative impacts. It has been established that the abundances of many of the covered species show a correlation with flow rates. Uncertainties about the level of spring and fall outflow will be addressed with two decision trees, one for fall and one for spring. It is argued that the decision-tree process will run for about 10 years and inform the initial operations of CM 1. Targeted studies will address this uncertainty before the new facilities are operational, but there is no description of these studies or a clear designation of how optimal flow rates can be balanced for different species. The decision-tree process will focus on longfin smelt and Delta Smelt with consideration of salmon and sturgeon but no apparent consideration of other species. It is not clear what would be done if 'optimal' flows differ across these species. Moreover, other species abundances such as young-of-the-year striped bass also correlate with flows, and there is no consideration of potential changes in abundances of these young predators. Overall, it is stated that a science plan and data collection program will be developed and implemented but the design of that program is not stated, the amount and source of funding not identified, and the experiments to be done not determined. If the success of the studies is dependent on having years with a range of flow conditions, then success is uncertain at best. It is impossible to determine if the proposed research program will be adequate to address either the uncertainties that have been identified or the hypothesized causal mechanisms (turbidity, suspended solids, temperatures, salinity) that might lead to more informed flow operations.

Species Differences and Interactions

Overall, there was little consideration of interactions and synergies among species. Also, potential impacts on other ecologically important species in the ecosystem have been ignored or inadequately presented.

Because species were assessed individually in the evaluation of the effects of water operations, significant differences in effects among species were identified. In contrast to the detailed individual species discussions, the nine non-covered species were lumped and considered as a group in Chapter 11 because the effects of most conservation measures "on non-

covered fish and aquatic species would be similar for all non-covered fish species included in Chapter 11." First, no reason is given as to why the nine non-covered species are included and others excluded apart from being "identified by state or federal agencies as special status or of particular ecological, recreational, or commercial importance." (page 11-1, lines 29-30). Clearly, one could argue that there are other species that have major ecological impacts in the Delta (e.g. two invasive clams) or that might be abundant and have competitive interactions with covered species (perhaps the centrarchids). Also, if habitat restorations become fully functional and provide predator refuge, feeding areas, or sources of food for covered species, the restorations must have impacts on many (perhaps hundreds) other species including the listed non-covered species. Some of these other species, such as nonnative predators and invasive clams, may also benefit from these expanded habitats. Benefits for the other species may dampen any benefits of the habitat restoration for covered species.

Second, the nine non-covered fishes and invertebrates have a huge range of ecological tolerances and requirements, life histories and behaviors. It seems unlikely that effects would be similar across all of these species. The treatments of covered species in the DEIR/DEIS revealed very significant ecological differences among species and even life stages. At best, this approach seems overly simplistic because we expect that individual species will have different responses to the proposed actions. At worst, this sort of lumping could lead to wrong conclusions because both predators (e.g. striped bass) and their prey (e.g. shad, California bay shrimp) are combined. Some of the proposed actions, for example in-flow conditions, might favor a particular covered species but may also favor a non-covered predator such as striped bass. Some further justification for this approach should be given, particularly because some of the non-covered species have strong interactions (e.g. predation) with some covered species.

Likewise, lumping phytoplankton, zooplankton and predators may also enhance uncertainty because clams can alter phytoplankton species composition, fish feed selectively on different types and sizes of zooplankton, and predator species differ in prey choice, feeding behavior, and thermal/habitat requirements. Other important elements of the food web in these habitats, such as emergent and submergent macrophytes and edaphoic microalgae, were ignored. Moreover, there are literally hundreds of species of macroinvertebrates as well as other fish species that are ignored in the DEIR/DEIS, although these species play an essential role in the ecological functioning of the Delta ecosystem. It is difficult to draw species-specific conclusions based on the grouping of some species and exclusions of important food web components such as the invasive clams. We do not suggest that multispecies biological models are required but we do suggest that some sort of balance and rationale be given for species lumping and exclusions so that uncertainties in conclusions can be better understood and underlying assumptions can be formally expressed.

It is not clear how the interactions among species are considered in time and space. Much of the DEIR/DEIS was focused on a detailed discussion of how an individual conservation measure (or a component of a conservation measure such as construction) might impact a specific species or life stage of a particular species. For example, each of the 11 fish species is discussed separately and extensively. However, there was an absence of consideration of interactions and synergies among species. We know we can't really manage species by species, and what is beneficial for one may be adverse for another. This concept has not been adequately captured or addressed. As mentioned, this becomes particularly important in the discussions of habitat restoration, which is intended to provide new food resources in the restored area and to the Delta. There is no consideration of how suggested increases in zooplankton food supply will

be distributed among the target species. There is likely to be competition for these limited resources among covered species or with other species not considered. Information about who uses those resources is critical but not fully considered in the assessment. Food-web models do not adequately consider predators or competitors of the covered species. It did not appear that any biological feedbacks (e.g. resource depletion) were used in the analyses.

Delta Connectivity

Overall, there was little consideration of interactions and synergies among different proposed CM actions or between different geographic regions within the Delta and beyond the Delta.

It is not clear how the cumulative effect of restoration in different parts of the Delta is addressed. Conservation measures are planned in many different locations throughout the Plan Area and it is suggested that negative impacts in one area can be offset by positive impacts in another area. This necessarily contains an implicit assumption that the entire Draft BDCP area is functionally interconnected both physically and biologically. It assumes that CM impacts on a particular life stage of a species in one part of the Delta can be balanced by other CM impacts that may occur at other times, on other life stages, and in other locations. This has not been demonstrated.

Additional consideration is needed of how factors outside the BDCP area interact within the BDCP area. The DEIR/DEIS included some forcing factors (such as climate change, tides, reservoir and upstream flows) and to a certain extent the potential for new invasive species from outside the BDCP area. Yet there is little discussion of biological influences or migrations from outside the BDCP area. A good example is longfin smelt, which has a baywide ecosystem distribution. Changes in flows may be very important in migrations into the BDCP area and the role of these smelt in other parts of the Delta. While the connectivity of the Delta ecosystem was not addressed for longfin smelt and other species, we note that the life cycle model for salmon does acknowledge the fact that salmon spend different portions of their life in different regions of the Delta, San Francisco Bay and Pacific Ocean systems, and are impacted by how long they spend in the Delta and the timing of migration through the Delta. This approach was not used for other species. Also, there has been little effort to translate biological changes in the BDCP area to downstream regions.

Qualitative Analyses

The impacts on fish are largely assessed based on qualitative analyses, including expert judgment. The relation of these analyses to the specific models presented in the Effects Analysis (Chapter 5 of the Draft BDCP) is not clear. The qualitative analyses seem to conclude that the negative impacts of construction and flow operations will be minimized through Adaptive Management of operations and that the other conservation measures (in CM2 – CM22) will be beneficial and largely make up for the negative impacts. Since the relative degree to which any conservation measure will increase/decrease the production of a given fish species is unknown, it is invalid to calculate net effects. This type of statement is invalid in a qualitative comparison because: 1) the relative degree of the negative and positive impacts is unknown, and 2) CM 1 and CM 2 -22 impacts may operate on different life stages of a species. Some life stages may be more critical than others (e.g. bottlenecks).

The assessments of effects of each part of each conservation measure on fish and aquatic resources are qualitative, with considerable uncertainty in the conclusions reached. The methods

used to assess net effects are drawn in part from DiGennaro et al. (2012). The relative importance of a BDCP attribute (or stressor) affecting each life stage of each of the covered species was assessed largely by expert judgment (on a scale of +4 to -4) during a workshop. Scores were based on importance (none = 0, very high = 4) and on the basis of the degree of change of that attribute caused by the Draft BDCP. These analyses could have been strengthened by:

1. Conducting an independent assessment by a second group of scientists. Conclusions are only as good as the expert judgment and without replication, uncertainty is high.
2. Qualitative analyses should include and fully document assumptions. The analyses need to recognize that conclusions largely provide a mechanism for verbal description of potential effects and provide a hypothesis of effects rather than any predictive forecast.

Net effects and the degree of certainty are tabulated for each attribute (e.g. Figure 5.5.1-5 for Delta Smelt and 5.5.3-4 for winter-run Chinook). Attempts to qualitatively balance positive and negative impacts (i.e. positive benefits compensate for negative impacts) are not valid because the relative strengths of these impacts are unknown. The authors need to fully recognize the uncertainties inherent in the DEIR/DEIS analysis rather than simply providing tables stating no net effect. Moreover, the net effects analysis is highly uncertain because the combined importance of all effects was a subjective analysis of the attribute scores. Another group of experts may reach a different conclusion.

Full Life cycle considerations

For the covered species, each CM is often evaluated for each life stage of the species. It is often claimed that negative impacts of one CM and usually on one life stage can be offset by another CM that may be acting on another life stage. This type of analysis assumes full biological functionality and physical/ecological connectivity across the region and among the areas where CMs are being applied. Moreover, it assumes that all life stages are equally important. Consideration should have been given to what is currently restricting a species production and an acknowledgement that actions on that bottleneck are likely to have a higher impact than actions on other life stages. For example, if larval recruitment is a serious life-stage bottleneck, then it is not clear that any efforts to improve juvenile conditions will have population-level impacts. We recognize that it is difficult to make these kinds of assessments until after there is a better understanding of the complete life cycle and the operations of stressors. Yet this limitation or added uncertainty needs to be addressed, particularly when conclusions are being made about ‘net effects’. The OBAN and IOS life-cycle models that focused exclusively on Chinook salmon do not do this and do not include most of the CMs. A number of other life cycle and bioenegetics models for other species were excluded from consideration. Some of these models (e.g. smelt) could be quantitative and apply to specific questions raised in the Draft BDCP.

Adaptive Management

Several very specific Biological Goals or targets are defined in the Draft BDCP. For each species-level Biological Goal there is a variety of CMs that could contribute to that goal. Adaptive management is a key part of the overall Draft BDCP. However, given that a number of CMs apply to a number of species, there is no explanation of how adaptive management will be

used to target the specific CM that is causing any changes observed for individual species. Research will need to be carefully designed to understand the causal relationships. There is no description of: (a) how individual targets or thresholds will be determined across time to trigger an action, (b) how much progress is needed to maintain a particular action, (c) how much negative change would need to be observed to effect a change in the CM, or (d) what would happen if results were mixed across species (i.e., some covered species received a positive benefit and others received a negative benefit).

Uncertainty

The Delta is a physically, chemically and biologically complex ecosystem. There has been extensive research, monitoring and modeling for the Delta area but much remains unknown, particularly with respect to causal mechanisms. The ecosystem has also undergone major changes in hydrology and water flow, habitat structure, and biological composition, including a reduction in a number of species and massive invasions by others (e.g., clams). Much of this complexity and change has been captured in the various sections of the Draft BDCP as well as some of the individual species descriptions in Appendices to Chapter 11. In this context, the DEIR/DEIS analyses are designed to predict the nature of the changes that might occur over the next five decades due to construction and operations of a massive new water conveyance system in the Delta and a series of efforts to restore habitats and institute a number of other Conservation Measures. All of this is done under major known or estimated (climate change, population increases) but also unknown (new invasive species or discovered causalities) changing environmental conditions. This is a daunting challenge.

Ultimately, the question is whether and what sort of effect the combined CMs will have on key covered species and on the ecosystem as a whole. It is critical to be able to balance negative effects with positive effects. To a large degree the relative impact of any one CM remains uncertain and ‘conclusions’ of net effects analyses could be better termed ‘hypotheses’. There are uncertainties in causality, the analyses performed, the future unknowns and changes, or responses of other species and ecosystem components that are not considered, any or all of which could have indirect and unintended consequences.

We recommend that this uncertainty and the many underlying assumptions be dealt with upfront, forcefully and directly. There is uncertainty throughout all of these discussions. Quantitative estimates of uncertainty are rare. Moreover, the handling of uncertainty seems inconsistent throughout. The uncertainty of the level of understanding of the factors limiting species production, model validity, and overall conclusions reached are more clearly acknowledged in the Draft BDCP than in the DEIR/DEIS. Sometimes the uncertainty in the data or models is used to outright eliminate the application of certain models (e.g., fish life cycle models). Other times the uncertainty in the output is stated as the conclusion (i.e., no conclusion can be drawn). Sometimes the uncertainty is mentioned, and yet other times the uncertainty is not mentioned at all. In general, the latter becomes more common as one moves from the Draft BDCP to the DEIR/DEIS details to the Summary parts of the chapter. Often the rollup summaries are not reflective of the uncertainty of the issues expressed in the body of the report. Rollup of conclusions tend to downplay uncertainties. A typical example of this is on page 11-18 “The effects of the restored habitat conditions (CM 2…CM 4…CM 5…CM 6…and CM 7…) would be beneficial for all covered species because there would be an increase in the amount of habitat as well as food production in, and export from, the restored areas”. The certainty of this conclusion is not reflective of the uncertainty of the analyses.

Table 11-1A-SUM2 is another example of the problem mentioned above. Data clearly show a relationship of outflow to splittail abundance and any reduction in that flow might have a negative impact. Although the DEIR/DEIS claims a positive impact from the Yolo Bypass, the table itself shows the net effects of flows on splittail are not adverse, less than significant or even beneficial. These types of conclusions without precautionary notes about uncertainties or assumptions can be misleading.

In addition, there are clearly many assumptions that are necessarily part of any such analyses. We suggest that the fundamental assumptions be succinctly stated up front in each section. Statements of assumptions allow a more logical evaluation of conclusions, and would provide a more balanced and understandable presentation of the methodology used.

Cumulative Effects

The analyses are targeted toward assessing impacts over a 50-year period. Yet, many of the effects on individual fish are evaluated at points in time, normally only for a year or for a particular life stage. It is possible that a low impact (positive or negative) of a few percent during a year can have a significant effect if accumulated (and compounded) over each year for 50 years, but it is not clear if this been incorporated into any of the biological models. The multi-year modeling of growth, reproduction and mortality of Delta Smelt is a good example of existing quantitative approaches that could be applied (Rose et al. 2013a 2013b). Simple bioenergetics models could have been used to assess effects of changes in temperature on fish growth rates.

Additional General Questions/Points

- Temperature plays a key role in fish growth, reproduction, and physiology, and behavior is often very sensitive to even small changes in temperature. Although temperature was considered in the sturgeon analyses it is not clear that it was fully considered in other species, particularly for those where temperature might be near critical thresholds. Temperatures might be affected if changes in flow rates affect the degree of tidal intrusion or residence times of water in the system.
- Flows are considered important to many fish species, yet the causal relationships of fish abundances with flows remains enigmatic. Will research and monitoring (e.g. as part of the decision-tree analyses) include measures of other potential forcing factors such as water temperature, predation rates, suspended solids, salinity, and food densities?
- How were (or will) thresholds or tipping points be considered in the analyses or adaptive management programs?
- There was very little discussion of the two invasive clam species which, according to the published literature, have had a huge impact on the ecological functioning of the Delta ecosystem (e.g. changes in chlorophyll levels, species compositions, *Microcystis*). Were they fully considered in the analyses of habitat restoration and potential new food sources? Clams may likely consume portions of any new food produced. They are a key ecological component of the ecosystem and should be specifically considered.
- Wherever possible, modeling should show ‘bracketed results’ or ranges of uncertainty.
- Propagation of errors in physical/hydrodynamic/hydrological models will be compounded when then applied to biological models as forcing functions.

IV. References Cited

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CHAPTER 12: TERRESTRIAL BIOLOGICAL RESOURCES

I. Overall Assessment

Chapter 12 uses a logical approach, a wealth of detail, and thoughtful analysis in evaluating potential impacts to terrestrial habitats and organisms. Unlike the rest of the DEIR/DEIS, it makes many of its findings accessible in a comprehensive lead-off summary. Like the rest of the DEIR/DEIS, however, understanding and evaluating the material in Chapter 12 requires frequent referencing to other chapters, and to multiple places in the Draft BDCP.

Our main concerns:

1. *Losses and gains of habitat*—To simplify estimates of losses and gains in habitat, the chapter equates a species' habitat with one or more natural communities. This simplification weakens the link between habitat value and habitat losses and gains and contributes to uncertainty in the calculations.
2. *Timing of restoration*—The chapter sets optimistic expectations about the time required to replace a mature habitat of slow-growing terrestrial species.
3. *Restoration effectiveness*—There is an implicit assumption that the projected habitat gains from restoration and protection needed to offset habitat losses associated with BDCP actions will be fully realized. Experience suggests that this is rarely the case.
4. *Performance measures*—The chapter lacks detailed metrics of desired ecological results of the various conservation measures, even as summaries derived from the Draft BDCP.
5. *Adaptive management and monitoring*—Adaptive management is frequently mentioned as the solution if things don't work out as planned, yet few details are provided (these are in the Draft BDCP) and lessons from terrestrial habitat restorations that were managed adaptively are scarce or absent. Implementing the Draft BDCP will require extensive monitoring landward of the traditional coverage through the Interagency Ecological Program. The demands for monitoring may be underestimated (and therefore underfunded).
6. *Contingency plans*—It is unlikely that all the actions and measures in the Draft BDCP will play out as planned. Beyond calling on adaptive management, there is little indication of any back-up plans if habitat restoration falls short because of funding, unwilling sellers, climate change, or other factors.
7. *Linkages among species or actions*—In contrast with the Draft BDCP's emphasis on linking conservation measures in space and time, Chapter 12 mostly treats each species and each action independently of other species and actions.

II. Scope

Chapter 12 of the DEIR/DEIS, which addresses the potential impacts of Draft BDCP conservation measures on terrestrial biological resources, begins with an informative summary.

Effects on natural communities, covered plant and animal species, and other species of concern are considered; most of the attention is focused on individual species. The general approach to gauging impacts, compensating actions, and mitigation for species is to: (1) use available information to construct a habitat suitability (HSI) model for the species; (2) use the model in combination with GIS to determine where available habitat occurs, weighted by habitat value; (3) overlay the areas that will be affected by various actions under the conservation measures to determine the loss of available habitat; (4) compare the amounts (and occasionally locations) of habitat to be restored or protected to determine whether they compensate for losses; (5) supplement with Avoidance and Minimization Measures (AMMs) and/or other specific management actions to enhance the value of restored or protected areas or reduce impacts; and (6) where necessary, implement additional Mitigation Measures to ensure sufficient habitat availability.

This is a logical approach. The analyses of impacts on natural communities and species from the conservation measures associated with the Alternatives are comprehensive and detailed. In most cases, the proposed habitat restoration will more than compensate for the losses associated with construction and operation. Where it falls short, additional actions are proposed. For example, loss of acres of vernal pool complex is estimated to be greater than replacement through protection and restoration in the near term. The difference is anticipated to be addressed through a variety of restrictions on activities or AMMs: "With these AMMs in place, Alternative 4 would not adversely affect vernal pool complex natural community in the near-term" (page 12-2048; unless otherwise noted, all page references are to the DEIR/DEIS documents).

Numerous AMMs and Mitigation Measures are proposed to supplement the habitat protection and restoration measures. In many cases, these involve conducting surveys to obtain additional information on distribution in the study area (e.g., Mitigation Measure BIO-55, page 12-2161), target and protect sensitive areas (e.g., Mitigation Measure BIO-75, page 12-2241), or evaluate the potential effectiveness of proposed conservation actions. For example, the loss of managed wetland habitat for shorebirds and waterfowl in Suisun Marsh would be mitigated by the protection or restoration of 5,000 acres of seasonal wetlands, assuming that: "1) existing managed seasonal wetlands on average in Suisun Marsh provide low biomass and low-quality food to wintering waterfowl and 2) protected seasonal wetlands can be managed to produce high biomass and high food quality. However, the food biomass and productivity in Suisun Marsh would need to be quantified in order to determine if the 5,000 acres was sufficient to avoid an adverse effect on wintering waterfowl in the Suisun Marsh, or if additional mitigation would be needed. Mitigation Measure BIO-179a, Conduct Food Studies and Monitoring for Wintering Waterfowl in Suisun Marsh, would be available to address this adverse effect" (page 12-2561). Many of the AMMs or Mitigation Measures are quite detailed, evidencing sensitivity to the specific ecological requirements of the species.

III. Quality of Analysis

The amount of detail provided in Chapter 12 and its appendices is impressive. There are numerous instances in which the treatment of potential impacts and the measures proposed to counteract them are thoughtful and comprehensive. In some cases, the analysis delves into great detail about what might seem to be potentially minor effects. Concerns are raised, for example, about possible alterations of the photoperiod of sandhill cranes due to lighting at construction sites or on new roadways (page 12-2210). In other situations, however, little supporting detail is provided or the reader is referred to material in other chapters or in the Draft BDCP.

Chapter conclusions

The overall conclusion of the chapter is that the only non-mitigable impacts of BDCP actions would potentially affect bank swallows, through disturbance and/or loss of breeding habitat, and giant garter snakes, through disruption of movement corridors by canal construction (for Alternatives 1B, 2B, and 6B) (see pages 12-3229 – 12-3243). Additionally, although sufficient conservation acreage would be provided by the conservation measures to offset near-term effects of Alternatives 1A, 2A, 3, 4, 5, 6A, 7, 8, and 9, "insufficient cultivated land would be protected (and enhanced) under Alternatives 1B, 1C, 2B, 2C, 6B and 6C to offset loss of habitat for species that use cultivated lands for foraging. Alkali seasonal wetland complex and vernal pool crustacean habitat (alkali seasonal wetland complex and/or vernal pool complex) would need to be restored and protected in addition to what is currently in the Plan under Alternatives 1C, 2C and 6C, as described in Mitigation Measures Bio-18, Bio-27, and Bio-32" (page 12D-39).

Although an EIR/EIS is required to identify the "unavoidable significant environmental impacts" of a project pursuant to Section 15126.2(b) of the State CEQA Guidelines, the non-mitigable potential impacts of BDCP on bank swallows and giant garter snakes (or, indeed, on any terrestrial biological resources) are not included in the broader listing of impacts and mitigation measures in Chapter 31 (Table 31-1).

Areas of concern

Finding what one needs to know to understand or evaluate a particular statement or conclusion in the DEIR/DEIS often involves a considerable amount of searching through thousands of pages, as well as delving into referenced (and non-referenced) material in the Draft BDCP itself. Based on our attempts to do this, we have several concerns with the treatment of terrestrial biological resources.

Losses and gains of habitat

Assessing the potential impacts of Draft BDCP actions begins by determining how much (acreage) of a given habitat is lost or converted to something different—i.e., the "footprint" of the action. The loss is then offset by restoring or protecting an equivalent or greater amount (acreage) of the lost habitat. The calculations in the DEIR/DEIS are therefore made in acreages. There is an implicit assumption that an acre lost can be replaced by an acre gained. The DEIR/DEIS discusses two approaches for dealing with cases in which the gains don't balance the losses. First, it is frequently proposed that the replacement habitat is of greater value. Second, the calculation of "mitigation ratios" (how many acres should be restored or protected to replace an acre lost) considers factors such as importance (value) of habitat to a species, species rarity, threat levels, and uncertainty about the effectiveness of restoration (see page 12D-3). Although this seems to be a reasonable approach to gauging mitigation efforts, it would be good to know how uncertainties of restoration effectiveness were assessed.

"Habitat" for natural communities is determined by classifying communities into several types, which are then mapped. For species, "habitat" is defined through the development of habitat suitability (HSI) models. The results are then used to calculate potentially available habitat and what habitat might be lost or gained as a result of Draft BDCP actions. The details of the HSI models are not in the DEIR/DEIS but are provided in Chapter 2 of the Draft BDCP. These appear to be carefully done, making good use of available literature and unpublished

information; Appendix 2A of the Draft BDCP discusses the assumptions and underlying rationales for each of the HSI models. The DEIR/DEIS correctly notes that the models "do not necessarily indicate with certainty that covered species would not occur in all areas not identified as habitat; but instead indicate that these areas have a much lower probability of species occurrence compared with areas identified as suitable habitat. Habitat suitability models are a tool used to estimate impacts to obtain a maximum allowable habitat loss. On-the-ground surveys, performed by professional biologists, will determine impacts during implementation" (page 2A-4). In other words, lots of monitoring!

The specifications of habitat for a species derived from the HSI models are often quite detailed. In a listing of principles to guide the conservation strategy for aquatic species (Draft BDCP pages 3.2-5 to 3.2-7), the Draft BDCP correctly observed that "habitat should be defined from the perspective of a given species. Habitat is a species-based concept reflecting the physiological and life-history requirements of species. Habitat is not synonymous with vegetation type, land (water) cover type, or land (water) use type." Nonetheless, in calculating the habitat loss/gain functions that are the foundation of assessments of Draft BDCP impacts, habitat has been generalized to correspond with one (or more) of the natural community types. While this generalization was probably necessary to permit the analysis of habitat losses and gains using GIS analysis, much of the useful and important detail in the HSI models has been lost (although it reappears now and then in the AMMs and Mitigation Measures for individual species). Thus, there is often an unspecified (but potentially large) uncertainty associated with the habitat loss/gain calculations.

This uncertainty may be exacerbated by uncertainties in the distributional data that are used in concert with the habitat information to define where a species occurs, and therefore its vulnerability to the construction and restoration actions under different Alternatives. The distributional data (provided in a series of maps for the species considered) require several assumptions, most importantly that: (1) the distribution has been adequately surveyed, and (2) the distribution is stable. The distributional data come from a variety of sources over an unspecified time period (although the data sources may be given in some undisclosed location in the DEIR/DEIS or Plan). They are based largely on records in the California Natural Diversity Data Base (CNDDB). Because this is a presence-only database, confirmed absences (0 values) are ignored and can only be inferred, compromising its value. The database is also incomplete. For example, CNDDB contains only a partial download of records of bird distributions in the California Avian Data Center (CADC). This source of uncertainty is not acknowledged, nor are its potential consequences explored.

Uncertainties in the distributional information may also affect the assessment of habitat "value." There is frequent mention of the expectation that restored or protected habitat will be of greater value than the habitat that is lost to Draft BDCP activities, so the amount of replacement acreage may actually underestimate the "functional" acreage available to a species. "Value" is determined based on recorded distribution and abundance in different vegetation cover types and/or species' ecology. For example, for the giant garter snake, "the modeled upland habitat is ranked as high-, moderate-, or low-value based on giant garter snake associations between vegetation and cover types (U.S. Fish and Wildlife Service 2012), historical and recent occurrence records (Appendix 12C, 2009 to 2011Bay Delta Conservation Plan EIR/EIS Environmental Data Report), and presence of features necessary to fulfill the species' life cycle requirements" (page 12-2131). Although this approach is reasonable, it rests on the assumptions that: (1) current distribution reflects optimal habitat selection, (2) the distributions have been

adequately surveyed and are not undergoing rapid changes, and (3) the restored habitat will actually be better than the habitat lost. There is a clear intent to manage for improved habitat, considering such factors as spatial heterogeneity and connectivity; to the extent that this is realized, the last assumption is probably valid, but it does rest on an accurate understanding of the habitat requirements of the species.

Timing of habitat restoration

Habitat restoration is a complex and time-consuming process, The DEIR/DEIS recognizes this and devotes considerable attention to the timing of restoration efforts. In particular, plans are outlined to ensure that restoration is in phase with habitat loss, so that gaps in habitat availability to a species are minimized. Some restoration is scheduled to begin shortly after permitting of the BDCP, whereas conveyance operations will not begin for at least a decade (although construction of the intake facilities will begin soon after permitting). While this difference in phasing may help to ameliorate impacts of habitat loss for aquatic species, it will be less effective for terrestrial species and communities. For slow-growing flora, such as valley/foothill riparian woody vegetation (page 12-2015), or species that rely on mature habitats, such as black rails that occupy well-developed tidal wetlands (page 12-2165), or Swainson's hawks, white-tailed kites, Cooper's hawks, or ospreys, which require mature trees for nesting (page 12-2255), there may be a temporal mismatch between the loss of mature habitat components and restoration. It may take decades to redeem the lost value. For the latter species, "this time lag between impacts and restoration of habitat function would be minimized through specific requirements of AMM18 Swainson's Hawk and White-Tailed Kite, including transplanting mature trees in the near-term time period" (page 12-2255).

For something like a hawk, however, "habitat" depends on much more than having a suitable tree for a nest. Transplanting mature trees is challenging enough; one can't transplant an entire functioning mature riparian ecosystem. It is inevitable, therefore, that there will be a substantial gap between the loss of habitat for such species and the re-emergence of habitat that meets the full complement of a species' requirements. If this takes decades, population dynamics may be disrupted and local extirpation may follow. The analysis for the salt marsh harvest mouse, for example, warns that up to 20% of the species' habitat in the Draft BDCP area may be affected, diminishing the population and reducing genetic diversity, "thereby putting the local population at risk of local extirpation due to random environmental fluctuations or catastrophic events. This effect is expected to be greatest if large amounts of habitat are removed at one time in Suisun Marsh and are not effectively restored for many years, and if there are no adjacent lands with salt marsh harvest mouse populations to recolonize restored areas" (page 12-2485). The expectations for restoration of mature habitats, even if supplemented by Mitigation Measures and AMMs, strike us as unrealistically optimistic.

Restoration effectiveness

For many natural communities and species, the effects of CM1 on species are to be mitigated by the creation of restored habitat of equal or greater value in Restoration Opportunity Areas. For natural grasslands, for example, the analysis of long-term effects for NEPA projects a loss of 2,947 acres by the end of the BDCP timeframe. The 2,000 acres of restoration associated with CM8 and the restoration of temporarily affected grassland required by AMM10 (431 acres for Alternative 4) would not totally replace the grassland acres lost. There would be a permanent loss of 516 acres of grassland in the BDCP area. However, "the combination of restoration,

protection and enhancement of grassland associated with Alternative 4 would improve the habitat value of this community in the study area; there would not be an adverse effect on the grassland natural community" (page 12-2070).

In this example, as elsewhere in this chapter, one has the impression that there is full confidence that the projected gains in habitat will in fact materialize. There may be considerable certainty about the losses, particularly those associated with construction activities, but there is far greater uncertainty about the mitigation. Will the restoration actually be done? Where will it be located ("somewhere in a Restoration Opportunity Area" leaves a lot of uncertainty)? Will funding be adequate? Will appropriate areas be obtained from willing sellers? Will the species and communities come? Will climate change and sea-level rise erase the restoration gains? These questions are not adequately addressed, and the consequences of failing to reach the restoration, protection, or mitigation goals are not considered (at least in this chapter). Simply referring to adaptive management as a way to deal with such uncertainties is not sufficient.

One aspect of uncertainty that *is* addressed in this chapter (in Appendix 12D) is ecological feasibility: are suitable conditions present within specified conservation zones to implement the appropriate near-term conservation measures? Although the assessment explicitly excludes consideration of socio-economic or engineering aspects of feasibility, there is a comprehensive analysis of the presence of lands supporting required unprotected natural community acreage in specified conservation zones to support natural community protection, and of the presence of lands that meet suitability criteria, such as species range, soil type, land use, natural community, and land elevation to support restoration of natural communities or species habitat (page 12D-2). Appendix 12D is where one can find details about what goes into the determination of mitigation ratios, what principles will be used to guide the selection of areas for protection as part of the Draft BDCP reserve system, and what criteria might be used to judge the suitability of restoration sites. Although the treatment of these factors is generally excellent, the approach fails to consider how the spatial and temporal sequencing of restoration projects can influence their effectiveness in contributing to BDCP goals. Which sites are selected for restoration of habitats at one time may depend on which sites are already being restored and where they are. These sequencing effects may be particularly important for projects associated with waterways, where flows connect places. Such considerations are mentioned in the chapter in connection with the intent to include connectivity among habitats as a factor in planning, but the implications are deeper than that.

Climate change and sea-level rise can create additional uncertainty in habitat restoration efforts. We consider some implications for tidal marsh restoration in greater detail in Box 1.

Box 1. The ability of tidal wetlands to keep their heads above water as sea level rises

Impacts assessed

The anticipated outcomes of tidal marsh restoration under the Draft BDCP depend largely on whether new tidal marshes will survive the rise in sea level projected for the 21st century. Several of the Draft BDCP documents under review consider this question:

- Draft BDCP Appendix 3B, "BDCP Tidal Habitat Evolution Assessment," presents results of modeling that simulates the fate of marshes at Suisun Bay and in the Delta during the next 50 years.

- Draft BDCP Appendix 5E, "Habitat Restoration," refers to this modeling and, in three main places, provides background discussion (pages 5.E-37, EA.4-18 in section E.A.4, and 5E.B-9). Included is a proposed strategy of getting new marshes established soon, before sea-level rise accelerates to the rates forecast for late in the 21st century (page 5E.B-7).
- Draft BDCP Appendix 5.A.1, "Climate Change Implications for Natural Communities and Terrestrial Species," refers briefly to marsh accretion.
- DEIR/DEIS Chapter 12 repeatedly mentions accretion without analyzing it to the level of detail in Appendices 3B and 5E.

The background discussions include brief reviews of how marsh plants as well as suspended sediment can influence vertical accretion in tidal marshes. The references cited include recent journal articles about marsh accretion at the San Francisco Bay estuary (Callaway et al., 2011; Stralberg et al., 2011) and the best available measurements of below-ground productivity by *Schoenoplectus acutus*, the main bulrush among Delta tules (Miller and Fujii, 2010).

Doubtful projections

The accretion estimates in Appendix 3B rely on simplified modeling for Suisun Marsh and on an optimistic assumption for the Delta.

For accretion modeling at Suisun Marsh, Appendix 3B relies on a simplified method used by Orr et al. (2003). In this method, above- and below-ground contributions by marsh plants are assumed to raise the marsh surface by 1 mm per year, and the role of inorganic sediment is estimated from suspended-sediment concentrations. More recent models include specific factors for injected roots and rhizomes and for soil decomposition (Mudd et al., 2009; Kirwan et al., 2010; Kirwan et al., 2011; Fagherazzi et al., 2012; Takekawa et al., 2013). Such models do not appear to have been used in the Draft BDCP projections.

For the Delta, Appendix 3B assumes that marsh accretion keeps pace with sea-level rise (page 7). The report goes on to qualify this assumption: "The ability of marshes to keep pace with higher rates of sea level rise is not yet well understood" (page 8).

Outdated references

The related reference lists cite no post-2011 reports about tidal-marsh accretion excepting, in Appendix 5B, a piece by a science journalist (Kintisch, 2013). A more timely assessment might have considered the accretion modeling cited above and its implications for 21st-century tidal marshes. Also directly relevant are recently published observations of modern accretion rates in San Francisco Bay estuary marshes (Callaway et al., 2012; Thorne et al., 2013) and prior accretion rates in the Delta (Drexler et al., 2009; Drexler, 2011). Updated background on roles of inorganic sedimentation could cite recent reports on horizontal accretion (Gunnell et al., 2013) and coastal sediment starvation (Fagherazzi et al., 2013).

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Thorne, K., Elliott-Fisk, D., Wylie, G., Perry, W., and Takekawa, J., 2013, Importance of biogeomorphic and spatial properties in assessing a tidal salt marsh vulnerability to sea-level rise: Estuaries and Coasts, pages1-11, doi:10.1007/s12237-013-9725-x.

Performance measures

In view of the uncertainties that accompany many of the actions and responses that are part of the Draft BDCP, it is important to be asking continuously how well the goals and

objectives are being met. Performance measures are essential. For the Draft BDCP as a whole, performance is gauged in terms of progress toward meeting the biological goals and objectives that are part of the overall conservation strategy. All mentions of performance measures in the DEIR/DEIS simply refer to these goals and objectives. In some instances the accounts are quite detailed. For example, in the account for loggerhead shrike we are told: "Under CM11 Natural Communities Enhancement and Management, insect prey populations would be increased on protected lands, enhancing the foraging value of these natural communities (Objectives ASWNC2.4, VPNC2.5, and GNC2.4). Cultivated lands that provide habitat for covered and other native wildlife species would provide approximately 15,400 acres of potential high-value habitat for loggerhead shrike (Objective CLNC1.1). In addition, there is a commitment in the plan (Objective CLNC1.3) to maintain and protect small patches of trees and shrubs within cultivated lands that would maintain foraging perches and nesting habitat for the species. The establishment of 20- to 30-foot-wide hedgerows along field borders and roadsides within protected cultivated lands would also provide high-value nesting habitat for loggerhead shrike (Objective SH2.2). These Draft BDCP objectives represent performance standards for considering the effectiveness of conservation actions." (page 12-2428).

Most species accounts in the DEIR/DEIS, however, make no mention of objectives or performance measures. Instead, the biological goals and objectives are presented in Chapter 3 of the Draft BDCP (Table 3.4). The biological goals and objectives are either performance-based (was an action undertaken?) or results-based (did it have the anticipated effects?). For terrestrial resources, the objectives are mostly performance-based (which are easier to measure); results-based objectives are more difficult to measure, but they are ultimately what the BDCP project is all about. Chapter 3 of the Draft BDCP includes lengthy tables and text listing the biological goals and objectives and describing the underlying rationale for each; the specific monitoring efforts for compliance effectiveness *and* the specific metrics that will be used to judge performance; the major sources of uncertainty associated with CM1; and research actions necessary to reduce the uncertainties (performance can also be judged on the basis of success in reducing the listed areas of uncertainty). These are all important details. Even though these details are included in the Draft BDCP, their absence from the DEIR/DEIS, even in a summary form, diminishes its comprehensibility and scientific value substantially.

Adaptive management and monitoring

In a well-planned undertaking such as the Draft BDCP, performance measures should provide a frequent assessment of whether actions are having the desired effects. This is the domain of adaptive management. Adaptive management is *the* key to the success of the BDCP project over its 50-year duration. The adaptive management approach and administrative organization are described in detail in the Draft BDCP (Chapter 3, Section 3.6, and Chapter 7). Yet, adaptive management receives an even more cursory treatment in the DEIR/DEIS than do performance measures. Adaptive management is mentioned frequently in the DEIR/DEIS with no details about how it might be implemented; rather, it is often presented as a panacea for all problems.

Even so, there are numerous instances in which the elements of adaptive management are elaborated without the term being mentioned. For example, on page 12-2081, the amount of habitat restoration is adjusted depending on the rate at which habitat is lost (primarily through restoration of tidal wetland) and the timing of activities. Or on page 12-2233 it is proposed that if breeding occurrences of least Bell's vireo and yellow warbler are documented in the survey area,

consideration will be given to control of nest parasites and predators to foster population persistence. These are good examples of adaptive management based on field monitoring, although they are not presented as such. We consider adaptive management in detail elsewhere in this review.

Contingency plans

Monitoring and adaptive management are proposed to evaluate whether things are proceeding as planned. What if things don't go as planned? The history of ecological restoration tells one that restoration projects rarely result in exactly what is desired, when it is expected. Implementation of many of the AMMs anticipates that various activities (e.g., construction, roads) will be able to be redirected or retimed to avoid or minimize potential impacts. There will inevitably be situations, however, in which the adjustments are not possible or incur too great a cost. What then? Given the complexity and the high stakes of many of the actions to be undertaken in Draft BDCP, it would seem prudent to have contingency plans at least generally outlined *before* discovering that things aren't working. There is little mention of contingency plans in the event that a given action does not produce the desired results.

Linkages among species or actions

The Delta is a complex, interconnected place, in which what happens in one place at one time has cascading effects elsewhere at a later time. Correspondingly, the Draft BDCP undertaking is complex, with many things going on at different places and times, all linked together in different ways. The Draft BDCP and the DEIR/DEIS do not adequately acknowledge and consider these interconnections.

Both the Draft BDCP and the DEIR/DEIS do recognize the need to connect places undergoing restoration or targeted for protection. Establishing connectivity among patches of habitat to facilitate movement of individuals is considered as part of the planning for many species. Landscape ecologists distinguish between "structural" connectivity (i.e., what is seen on a map or a GIS image) and "functional" connectivity (i.e., how organisms actually use connections). The approach taken by Draft BDCP understandably relies on the former, in particular the patterns developed in the California Essential Connectivity Project. Without knowing the specific locations for habitat restoration within the broadly defined Restoration Opportunity Areas, however, it is difficult to evaluate how structural connectivity will be established in practice (although the intent is clearly there). Elements of functional connectivity might be incorporated into the planning by relying on the details of species' ecologies contained in the HSI models.

Connections among actions may be even more important than connections among places. Actions taken to benefit one species may benefit or harm other species. Thus, "Riparian restoration in those more interior portions of Old and Middle Rivers that would be managed for riparian brush rabbit habitat have potential to benefit resident western pond turtles because riparian-adjacent grassland is an important habitat characteristic for the rabbit" (page 12-2154). However, "the restoration programs will increase primarily wetland and riparian natural communities by converting agricultural land or managed wetland. The special-status and common plants and wildlife that rely on wetland and riparian habitats for some stage of their life will benefit from these changes over time. Other species that rely on agricultural land and managed wetland, but do not benefit from wetland and riparian expansion, may decline in the study area" (page 12-3226). In other words, some (perhaps many) actions will entail tradeoffs.

The importance of considering linkages among places and among actions is clearly stated in the conservation strategy of the Draft BDCP: “substantial benefits of the conservation strategy are derived from understanding interconnections between conservation measures across program elements, across the wide geography of the Delta, and across time. In short, the conservation strategy is intended to be greater than the sum of its parts” (Draft BDCP page 3.2-3; see also Draft BDCP pages 3.2-5 to 3.2-7). Aside from brief mentions (e.g., page 31-28 and following), however, the DEIR/DEIS fails to follow through on the intent of the conservation strategy, instead usually considering each species and each action independently of other species and actions. This may be necessary to comply with CEQA and NEPA formatting requirements, but that should not preclude a full consideration of interactions among species, habitats, and actions as well.

CHAPTER 13: LAND USE

I. Overall Assessment

This appears to be a document that was prepared first as a way of scoping out the difficulties that lay ahead w.r.t.? working with existing land use legislation more than as a document prepared for an EIR. It is surprising how little is actually uncovered, especially in any quantitative way, about anything. The chapter makes it very clear that the extensive habitat restoration plan in CMs 2-21 will inevitably conflict with land use regulations and be perceived as having negative impacts but that these will be addressed when specific locations are decided upon.

II. Scope

Every impact affects land use in some ways, there are other chapters on agriculture, recreation, socioeconomics, etc., so this chapter addresses how the project "bumps up against" federal, State, and local land use legislation, including the new Delta Plan. As such, it reads more like a layout of land use obstacles ahead than an actual analysis of land use impacts. This, of course, is because most of the land use impacts, beyond the tunnels themselves, are tied to CMs whose locations and operations are yet to be determined.

III. Quality of Analysis

Chapter section 13.1 provides an overview of existing land use by regions within the study area.

Chapter section 13.2 includes a seemingly complete legal/planning review of land use regulations, including the regulations of the DPC Land Use and Resource Management Plan (LURMP) for the primary zone that became effective in November 2010. The text makes it clear that nothing in this law is applicable to State agencies such as DWR. Numerous additional planning efforts and their regulations including the Delta Plan are summarized.

Chapter section 13.3 addresses environmental consequences. Aerial techniques were used to determine existing land uses in the project areas, impacts were determined by thinking through how the project would conflict with land use objectives, or be incompatible with existing land uses, or would physically "divide" communities. The document then indicates that most of these issues are covered in the other chapters. It also reviews compatibility with the Delta Plan requirements (Table 13.1).

Chapter section 13.3.3 identifies, for each Alternative, and sometimes by conservation measures, the potential acres where there are land use conflicts by city and county land use regulation categories, including possible mitigation measures. Analysis appears to have adequate consistency and thoroughness though everything is qualitative and the effects of CM2-21are even more vague because their locations are not yet specified.

Chapter section 13.4. includes the literature cited within the chapter and primarily consists of land use legislation and planning documents.

CHAPTER 14: AGRICULTURAL RESOURCES

I. Overall Assessment

As with all chapters, a summary comparative table of Alternatives with a short accompanying discussion would be useful. Here, only acres of land lost to agriculture are compared.

The analysis is limited to permanent and short-term losses of agricultural acreage, with little economic analysis or discussion. Farming is the primary economic activity in the Delta.

II. Scope

This chapter examines effects of project Alternatives on agricultural production in terms of permanent and short-term acres of farmland eliminated. This is nicely summarized in their Table 14-8, condensed for inclusion below as an example of a useful summary comparison table.

Table 14-8 (condensed). Estimated Conversion of Important Farmland as a Result of Construction of Water Conveyance Facilities, by Alternative (Acres)

	Perma-nent Subtotal	Short-term Subtotal	Grand Total	% Total Study Area
Alternatives 1A and 6A	4,984	1,329	6,313	1.23%
Alternatives 1B and 6B	18,875	2,144	21,019	4.10%
Alternatives 1C and 6C	13,014	3,170	16,184	3.16%
Alternative 2Aa	4,992	1,826	6,818	1.33%
Alternative 2Ba	18,868	2,669	21,537	4.20%
Alternative 2C	13,019	3,170	16,189	3.16%
Alternative 3	4,838	953	5,791	1.13%
Alternative 4	4,975	1,315	6,290	1.23%
Alternative 5	4,770	833	5,603	1.09%
Alternatives 7 and 8	4,883	1,105	5,987	1.17%
Alternative 9	2,459	559	3,018	0.59%

III. Quality of Analysis

This is mostly an acreage analysis, and omits most relevant economic analysis. Quite a bit of economic analysis capability is available for agricultural land and economic issues in the Delta, Yolo Bypass, and the Central Valley - very little of it has been used in the DEIR/DEIS.

Flooding from island failures. It seems that the No-Action Alternative should include some estimation of the likely flooding of some additional subsided Delta islands. The repair of all failed islands is not what has happened in recent history. Further, there is likely to be additional waterlogging of soils in a few areas that will reduce agricultural activity on some deeply subsided islands.

Salinity comparisons. Salinity changes should also be compared with the No-Action Alternative, as well as existing conditions. This seems to be a more relevant comparison. To what degree do these changes in salinity fall during the crop irrigation season? What is the economic impact of these changes in salinity?

Yolo Bypass inundation. For crop inundation in the Yolo Bypass, there is a nice study led by Richard Howitt quantifying these effects in general. This study is cited, but its results are not employed to give more precise economic impacts.

Estimation of land use and salinity effects on agricultural yields and revenues. Several Public Policy Institute of California studies have estimated agricultural land and economic losses from changes in the Delta using modeling for many individual Delta islands, including salinity effects. This work or similar modeling capability is not cited or employed. Far more quantitative economic and employment impact estimates can be made of the effects of changes on Delta agriculture, by county and even by island.

Waterlogging impacts and costs. It should be possible to have an estimate of the additional waterlogged area from seepage from the surface canal Alternatives, 1B, 2B, 6B. The relevant groundwater modeling results seem to appear in Chapter 7. Perhaps some of this land might be suitable for waterfowl habitat. Why are seepage impacts to agriculture not even roughly quantified? Modeling capability to make rough estimates is certainly available.

Losses from habitat conversion. Even though specific locations for habitat restoration have not been specified, it is still possible to come up with a reasonable range of likely agricultural and agricultural economic impacts. Several reasonable estimation methods are readily available.

Mitigations. An interesting range of mitigations for loss of agricultural land is proposed.

IV. References Cited

Howitt, R.E.,Medellin-Azuara, J., MacEwan, D., and Lund, J.R. (2012). Calibrating Disaggregate Economic Models of Agricultural Production and Water Management. Journal of Environmental Modeling and Software, 38: 244-258.

CHAPTER 15: RECREATION

I. Overall Assessment

In general, the material in this chapter is useful and informative to the Draft BDCP. However, inclusion of information such as mosquitoes as a public health risk for recreational users in the Draft BDCP area, further attention to specific CMs that affect recreational users in the Draft BDCP area (CM13: Invasive Aquatic Vegetation Control, CM15: Localized Reduction of Predatory Fishes, CM17: Illegal Harvest Reduction, and CM20: Recreational Users Invasive Species Program), and better linkages with other chapters would increase its applicability.

II. Scope

Chapter 15 details the physical environment, recreation facilities, and both recreation activities and opportunities in the Draft BDCP Area. There are numerous parks, extensive public lands, and private areas with many interconnected waterways that offer diverse recreation opportunities ranging from boating and fishing (the principal recreational activities) to camping, bird watching, sightseeing (e.g. wineries), hunting, wildlife viewing, trail hiking, walking and picnicking. The DEIR/DEIS focused primarily on: 1) how the actual construction and maintenance of new structures will impact recreational use at that location or in the immediate vicinity, and 2) how the operations of the water flow system (CM1) in each of the Alternatives might affect recreational opportunities. Most of the latter are focused on the frequency that reservoir levels will exceed the threshold set for recreational impairment.

Readers are referred to other chapters on Socioeconomics (Chapter 16), Aesthetics and Visual Resources (any changes in resources might affect their draw for recreation, Chapter 17), Fish and Aquatic Resources (changes in abundance or mix of recreational fishes or even the perception of changes might affect recreational fishing, Chapter 11), Public Services and Utilities (Chapter 20), Transportation (e.g. traffic patterns, Chapter 19), Environmental Justice (differential use of recreation facilities, Chapter 28), and Noise (Chapter 23) to review the assessment of how the Draft BDCP will impact these resources. Unfortunately, those results were not reconnected or cross-referenced to their impact on recreation, including tourism.

III. Quality of Analysis

An aspect of the recreational impacts not mentioned in this chapter that will be a consequence of all Draft BDCP Alternatives is covered in detail in Chapter 25, Public Health. This includes the increases in potential vectors of human and diseases, and especially of the biting nuisance caused by mosquitoes. For example, as stated elsewhere in the DEIR/DEIS, “Construction of the water conveyance facilities and water supply operations under all action Alternatives would result in an increase in sedimentation basins and solids lagoons. These new features could result in an increase in standing water, thereby potentially increasing vector breeding locations and vector-borne diseases in the study area” (page 25-34, lines 18-21). At individual construction sites near recreation sites or areas and in-river, construction would be primarily limited to June through October each year. This, of course, is the period of peak mosquito breeding and biting activity in the Delta. Moreover, the economic cost of nuisance mosquitoes is not discussed in either this chapter or in Chapter 25 of the DEIR/DEIS. Increases in mosquito populations will affect virtually all recreational activities in the Delta (e.g. fishing, camping, wildlife viewing, sightseeing), resulting in loss of recreational opportunities and increased human discomfort. Although there is a commitment to develop mosquito management

plans elsewhere, Chapter 15 of the DEIR/DEIS should include this topic as a direct cost on recreational activities in the Delta.

Also, Chapter 15 needs to pay more explicit attention to the other conservation measures because a number of these have the potential to have direct positive or negative impacts on recreation. For example, CM 17 (reduction of illegal harvest) would provide more fish for those who take fish legally. CM 20 might help reduce invaders, which would help the ecosystem overall but might come at a cost to boaters who would have to have their boats inspected. CM13 and CM 15 are both intended to reduce the local densities of 'nonnative predators' on selected species. These predators may likely include (although not specifically identified) the striped bass and largemouth bass that support much of the recreational fishing. The review should discuss how the predator reduction effort might affect fishing per se or the fishers drawn to this area to fish.

CHAPTER 16: SOCIOECONOMICS

I. **Overall Assessment**

None of the findings are robust given the nature of the analysis, but neither are they unbelievable (beyond the number of hotels). None of the socio-economic effects seem to be linked to environmental impacts. It appears that where the Draft BDCP will be providing compensation for its effects on Delta communities, it will be based on better analyses at the time.

II. Scope

This chapter attempts to predict the socio-economic effects on local communities in the Delta from project construction and operation. It draws on, and in some sense completes, the socio-economics analyzed in the chapters on agriculture and recreation. While the descriptive material is largely on the Delta proper, much of the formal economic analysis is for the five-county Delta region, with some effort made to split off from the Delta portion. The chapter spans economic impacts of tunnel construction and maintenance estimated in dollars and the qualitative effects of the project on "small town feeling." Social impacts are not considered under CEQA but are under NEPA. How economic and social impacts might feedback on environmental impacts does not seem to have been considered.

Because most of the data are for the five counties in the Delta, they are largely, or at least frequently, irrelevant. There are some data for individual cities within the Delta, and occasional reference to data that seem to be derived for the Delta itself. It is not always clear, however, which area the text is referring to.

Lastly, CMs 2 – 22 are not analyzed, though some unsubstantiated conjectures are made that they will have more serious impacts than the tunnel project and its operation.

III. Quality of Analysis

This chapter is largely descriptive, with a fair amount of pretty irrelevant quantitative information about the five counties as a whole included. The efforts to portray recreation and agricultural economic activity are based on existing and projected conditions, but even data sources for existing conditions are not well specified, or even plausible. For example, on page 16-21 starting on line 13 w.r.t. recreation we read:

> There are 98 hotels in the Delta with a total of 5,036 rooms. In the five-county region, there are 406 hotel properties with a total of 33,402 rooms. Slightly less than a quarter of all hotels and roughly 15% of all rooms within the five-county region are in the Delta.

These numbers are only plausible if West Sacramento and Stockton are included in the Delta. This would be fair, but much of the problem is that conventional models are inappropriate for describing the economy of scores of poorly connected islands with cities on their periphery, but cities better connected beyond the Delta than to the Delta. Much of the recreation and other data are ten years old or more. A private data provider (Claritas Marketplace) assembled data from the 2011 census supposedly so that it reflects the Delta, but how the data were assembled and transformed is not apparent. The numbers generally do not comport with casual observation.

Derived data were then used in a standard, widely used, input-output software package called IMPLAN at the "five-county Delta Region" or "five-county region."

IMPLAN includes (1) estimates of county-level final demands and final payments developed from government data; (2) a national average matrix of technical coefficients; (3) mathematical tools that help the user formulate a regional model; and (4) tools that allow the user to change data, conduct analyses, and generate reports. (page 16-43).

CHAPTER 21: ENERGY

I. Overall Assessment

The word "electricity" should replace every use of the word "energy" in this chapter. The reader should be reminded at the beginning of each section that this chapter also only deals with SWP and CVP electricity generation and use. Though short at 60+ pages, the chapter could be half its length by putting the purely descriptive material into an appendix. While the chapter shows that the electricity impacts are quite small, it makes surprisingly little reference to what the environmental impacts of changes in electricity use within CVP and SWP systems might be were the changes in electricity per chance larger.

II. Scope

This chapter evaluates the changes in the hydropower generation or energy usage associated with implementation of BDCP alternatives. Both the operations of CVP and SWP are considered. There is no mention of gravity feed. A change of energy consumption is expected due to both the construction as well as operation of BDCP facilities. An increase of energy usage is expected, which, if supplied by other sources, will have environmental (land use changes, GHG and pollution generation) and economic consequences.

The energy effects were evaluated under 2025 and 2065 conditions because of possible change of run off conditions and sea level rise due to climate change. Monthly TAF pumped at the north Delta intake for each BDCP alternative and No Action alternative were calculated using the CALSIM-II model, from which monthly and annual energy requirements were established for each case and were compared with existing energy usage. The upstream energy generation was assumed to be the same for BDCP baselines and alternatives since the upstream reservoir operations are largely controlled by natural runoff conditions; this is affected by climate change and inter-annual variability but not BDCP operational scenarios. The existing CVP and SWP pumping facilities at the south Delta are estimated to operate with a maximum monthly energy requirement greater than that estimated for BDCP, and hence increased use of existing pumping facilities is not considered of consequence for energy impact studies. The energy use for pumping at the proposed North Delta pumping plants and at the existing Delta and south of Delta pumping plants are evaluated for each of the BDCP alternatives.

The chapter does not take a California or West Coast electrical systems view, only a California State and federal water systems view of electricity, and so it is not possible to assess any systemic implications with respect to increased use of gas-fired electricity generation, for example. No other type of energy use beyond electricity within the water system is considered. Thus, "Electricity Generation and Use within the SWP and CVP Systems might be a better title for the chapter.

III. Quality of Analysis

<u>Usage of Models, Inputs, Analysis and Uncertainties</u>

The energy calculations used are straightforward, and conducted by multiplying the monthly-pumped TAF by the energy requirement per water volume pumped (i.e., pumping energy factor - MWh/TAF), the latter being based on Bernoulli hydraulic head calculations and relevant efficiencies. The MWh/TAF was estimated by CALSIM-II for each alternative, and

CALCIM-II is arguably the best available for Delta flow calculations within the current regulatory framework. The pumping energy factors for south of Delta CVP and SWP water deliveries are assumed to remain the same for each of the BDCP alternatives and baseline, but the energy use varies with the annual deliveries. All assumptions appear to be reasonably sound and justifiable. Uncertainty estimates are not given, however, although for this case some putative estimates are possible. The chapter includes an extensive description of the electricity generation and use in the SWP and CVP that should probably be moved to an Appendix.

Summary, Possible Issues and Referencing

NEPA effects statements and CEQA conclusions are made for issues of major impact and a cumulative effects analysis is made. Essentially, the conclusion for each case is that there would be no adverse (NEPA) effect and that impact would be less than significant and no mitigation is required (CEQA conclusion). A concern with regard to these inferences is heavy reliance on CALSIM-II output, since significant uncertainties may seep in to calculations. The model does not take into account future climate change adaptation strategies that might be implemented and the model output is dependent on the regulatory setting for which the model is applied. If the model overestimates the energy requirements as stated in the DEIR/DEIS, then the conclusions will stand, but this is neither established in the DEIR/DEIS nor substantiated via proper referencing to existing literature. Overall, the methodology employed is sound and the calculation procedure represents sound engineering.

CHAPTER 22: AIR QUALITY AND GREENHOUSE GASES

I. Overall Assessment

The technical content of the chapter is of acceptable standards, but clarifications should be made in a revised version, especially with regard to ozone production and transport as well as including an analysis of greenhouse gas (GHG) fluxes from [CM2-11]. The chapter has done an admirable job in identifying the air quality impacts of CM1 and identifying the Alternatives that are environmentally benign.

II. Scope

Chapter 22 addresses local and regional air quality impacts of criteria air pollutants and toxic air contaminants (TACs) emitted or generated during the construction and operation of Draft BDCP Alternatives. GHG emissions associated with the project are analyzed in relation to regulatory limits as well as control measures. The Draft BDCP could facilitate new growth and development in SWP and CVP Export Service Areas, and air quality associated impacts of such growth are addressed in Chapter 30. Climate change impacts on project Alternatives are discussed in Chapter 29. They all are in the category of controversial community issues (ES Chapter 7).

The study area for air quality effects includes immediate surroundings of project activities, within 1000 feet of construction and operations. For GHG, the area is much broader due to the global nature of GHG forcing. Three (SVAB, SJVAB, SFBAAB) of the fifteen California air basins are identified as important for the study. Each of the air basins is described with regard to geography, climatology, air pollution, and meteorology. Air pollutants are considered in the framework of EPA criteria pollutants (which are further classified in terms of regional and local pollutants) as well as TACs. Health impacts of pollutants are identified and assessed. The National Ambient Air Quality Standards (NAAQS), CAAQS, and CCAA are outlined, and the attainment status of the three air basins in point are listed (Table 22-3). It appears that violations of NAAQS and CAAQS are prevalent in the three air basins with regard to ozone and PM, to the extent that they are classified as non-attainment. Increased emissions can be regarded as adverse, and Draft BDCP proponents are expected to develop an Air Quality Mitigation Plan (AQMP) to ensure that regulations and recommended mitigation are incorporated into future conservation measures. The GHG emissions are discussed in relation to climate change, CEQA guidelines §15364.5, CEQA OPR Advisory, DWR climate action plan, and California Global Warming Solutions Act (AB 32). TACs in California are primarily controlled through the Tanner Air Toxics Act (AB 1807) and Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588). Local laws may trump certain Federal and CEQA regulations.

Air pollutants and GHGs are generated during the construction phase as well as operation of the water conveyance facility [CM1]. In the former, the dominant emissions include those from mobile and stationary construction equipment exhaust, employee vehicle exhaust, dust from land clearing and earthmoving, electrical transmission, and concrete batching from onsite plants. As such, this DEIR/DEIS assumes a particular schedule and phasing of activities, which are imperative for emission modeling (Appendix 22A).

The potential air quality and GHG effects of CM1 and habitat conservation measures CM 2–22 have been analyzed, and the implications of CM1 on sensitive receptors associated within residential and recreational land use are evaluated quantitatively at the project level (within 1000 feet of the operations). The effects of CM 2–22 are evaluated qualitatively at the program level. It is argued that it may be sufficient to consider only the air quality and GHG impacts of CM 2-11. Cumulative analyses are also presented.

\ The three air basins cut across four air quality districts [YSAQMD, SMAQMD, BAAQMD, and SJVAPCD] that have different emission standards for criteria pollutants and TACs; *de minimis* threshold levels for each basin have been identified. Many of these districts are already either non-attainment areas or maintenance areas, so extra emissions can have significant impacts. The cases of construction and long term operations are analyzed separately for different (nine) Alternatives and nineteen potential impacts (AQ 1-19) are identified and mitigation actions are proposed. The analysis is fraught by the need to comply with or consider a myriad of federal, state and local environmental standards. CEQA standards are more stringent than NEPA, and neither imposes thresholds for GHG.

No-Action and Action Alternatives are considered in detail, using projections of future climate that include changes in temperature, precipitation, humidity, hydrology, and sea level rise. Some or all air quality districts are affected by the Alternatives. Given the uncertainty of pollution emissions in construction activities, the considerations are only qualitative for CM 2-11. In all, the emissions appear to contribute significantly to criteria pollutants during the construction phase but not in the operation phase. Mitigation actions are required and are proposed through a series of mechanisms such as fees and offset reduction programs.

III. Quality of Analysis

This chapter of the DEIR/DEIS has been done thoroughly and carefully, considering a myriad of sources and project Alternatives. The results are physically plausible, moreso for the construction activities than the higher the air quality impacts, and they occur during the construction phase (nine years), impacting only selected counties. The air quality (AQ) impacts of long term operation of conveyance facilities appear to be insignificant for all Draft BDCP Alternatives.

Best available modeling systems have been used for AQ and GHG modeling. Emissions from heavy-duty equipment land disturbance were calculated using spreadsheets based on the methodology and default emission factors from the California Emissions Estimator Mod (CalEEMod). Emissions have been quantified for both 2025 and 2060 conditions. As expected, some of the data on personnel and equipment are unavailable. Many assumptions were needed to be made, and they are clearly stated in Appendix 22A. Best available input data from DWR, EPA, ARB and ICF are used, and all conceivable sources have been incorporated in developing inventories. The effects of the Alternatives on AQ, criteria pollutants, and GHG emissions from construction and operations were assessed and quantified using standard and accepted software tools, techniques, and emission factors. The models employed are EMFAC 2011 (for traffic), CalFEMod (maintenance), AERMOD and variants (air quality analysis), and AERSCREEN (DPMs, assuming worst case scenarios based on individual sources).

The following comments are offered for further consideration:

(i) SMAQMD requires dispersion modeling of construction generated PM10 emissions, which has been performed using AERMOD. The results are presented in Appendix C in terms of tables with numerous data points that are very difficult to interpret and frankly many readers

would not care to read. It would have helped if the results were presented in graphical form. This is particularly important since PM10 background concentrations currently exceed CAAQS and comparisons between the No-Action Alternatives and Action Alternatives are important. How much do the construction activities increase PM concentration under various CM 1 Alternatives? Are they contributing to extra exceedance days? These are some questions that are important to answer. AERMOD is a source dispersion model and its capabilities are limited in the absence of well-defined mean winds, such as the case of Schultz eddy formation or summer days where slope flows may dominate in complex terrain.

(ii) No model evaluations have been done using current or past data, and hence the results have large uncertainties. If the models have been evaluated for the area, some references would be helpful.

(iii) It is curious why the ozone issue has not been addressed although there have been lengthy discussions in the introductory sections on ozone and its health impacts. Table 22.3 shows that there are substantial numbers of ozone 'exceedance' days and the areas concerned are in non-attainment. Conversely, CO and NOx thresholds are rarely exceeded but the discussions and analyses of them are extensive. Perhaps it is assumed that control over precursor emissions may reduce the chemical products, but this needs to be justified and illustrated quantitatively.

(iv) The suite of models used does not include any photochemical models, and hence the formation of secondary pollutants (e.g., additional PM2.5) is excluded. In the project area, there is considerable land area with agriculture, and hence secondary pollutants can be important. A statement of the reason for exclusion (mainly comes from possible growth in agriculture) is in order.

(v) Prolonged and tortuous discussion of federal, state, county, and local standards, guidelines, and recommendations as well as discussions on modeling made reading this chapter very difficult. Some of the boiler plate material on criteria pollutions and their impacts may be removed (or relegated to an appendix), paving way to a more clear flow of essential material.

(vi) Fundamentals of global warming are described at length in the Chapter, but some of the discussion is redundant and others would fit better in Chapter 29.

CHAPTER 23: NOISE

I. Overall Assessment

In all, the section on noise pollution in the DEIS/DEIR is rigorous and extensive, and some further considerations are in order to account for possible noise refraction at night. Given uncertainties, most of the inferences are qualitative, and are expressed in terms of impacts on the overall Draft BCDP Plan area rather than those over individual counties, communities, and cities that may have their own noise standards. Given the overall inference that the project may have adverse noise consequences (NEPA conclusions) and that the cumulative noise impact is considerable (CEQA conclusions), the Noise Abatement Plan (Appendix 3B) based on BMPs needs to be carefully designed and executed. Suggestions for improvement of this chapter include an earlier termination of trucking and construction activities, initiation of noise monitoring at specific construction sites along with seasonal monitoring, focusing on the mitigation of noise from the long-term operations related to conveyance facilities, including terrain and buildings in models, and changing the accepted background noise condition of 40dBA.

II. Scope

This chapter identifies potential impacts of construction (short-term), maintenance, repair, and operational (long-term) noise related to existing conveyance facilities and conservation measures as well as Draft BDCP Alternatives of the conveyance components CM 1 and conservation measures CM 2-CM22. The No-Action Alternative does not significantly change the noise levels, and status quo is expected to continue, unless in the event of catastrophic events such as levee failures. On the other hand, Draft BDCP Alternatives appear to have a significant impact due to new construction, operations, sensitive land use, worker-exposure and transportation-scenario changes. A comprehensive assessment of impacts and mitigation measures is proposed and analyzed for Draft BDCP Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 5, 6A, 6B, 6C, 7, 8 and 9 for specific operational scenarios, followed by a cumulative analysis of noise and vibration impacts.

The goal was to consider the area encompassed by the Draft BDCP and areas of Additional Analysis (§ 4.2.1.1), but the DEIR/DEIS excludes the SWP and CVP Export Service Areas Region. Considering the localized nature of the sound and vibration effects, this assumption is justified. Existing environment is taken to be typical of a quiet rural setting. The potential noise effects due to growth inducement are addressed in Chapter 30. Chapter 23 gives a good overview of different measures of specifying environmental acoustic effects, including the daytime-nighttime noise levels (DNL, from 10 p.m. to 7 a.m.) and California Community Noise Equivalent level (CNEL, specific to 7-10 p.m.). The issues identified are ground-borne vibrations as well as noise propagation through the atmosphere.

The regulatory framework includes both Federal and State. The former does not have regulatory limits for noise, but recommends limitations for specific sources such as trucks, trains and aviation (e.g., FHWA, OSHA, FRA, FTA) as well as guidance for Aquatic and Biological Resources (Chapter 11) and Terrestrial Biological Resources (Chapter 12). The California Noise Control act requires the Office of Noise Control to work with communities in developing local

noise control programs based on best management practices, which is addressed well in this chapter. The procedure involves analysis and quantification of current and projected noise sources. DWR and USFWS provide guidelines for installing sound walls to shield project activities, and the decision is centered on the increase of (A- weighted) sound levels relative to a threshold of 60 dBA. In the backdrop of such an extensive but voluntary regulatory fabric, this DEIS/DEIR has done a thorough job of identifying existing noise levels in each potentially affected jurisdiction (which is also the NEPA/CEQA baseline) and assigning specific noise sources associated with the project. For the analysis purposes, a 40dBA level is assumed as the background, which is a reasonable value considering that most project activities are taking place in rural areas.

Major sources considered are the traffic noise, ground-borne vibrations and noise from construction machinery. The estimated peak hour construction generated traffic is based on Appendix 19A, the Construction Traffic Impact Analysis Report. No-Action Alternatives, no project Alternatives, and cumulative impact condition are well covered (e.g., see Table 23-15). Local and county noise restrictions are well laid out, and potential environmental impacts of noise pollution are well articulated.

The DEIR/DEIS identifies mitigation measures to remediate for significant impacts. Some of the aspects covered are: ground-borne vibration levels (VdB level) due to operation of heavy drilling and excavation equipment, noise exacerbation due to surface construction equipment, deliveries and worker commutes, and earth moving activities at off-site burrows and spill areas. Effects analyses included noise exposure of communities as well workers at conveyance facilities. Detailed discussions are given on activities that have the potential to exacerbate noise, such as construction of intakes, tunnels, forebays, barge unloading facilities, pumping stations, conveyance facilities, and transmission lines, with a focus on daytime, evening, and nighttime operations. The difficulty of the analysis is clearly recognized, in that the types of equipment, times of operation, and the period of usage are difficult to predict as are the periods of operation of different noise sources. As such, conservative, worst-case estimates are considered where all equipment is assumed to be operating simultaneously. In most cases, the noise is identified to produce significant effects, and thus implementation of best noise-reduction practices as well as working with communities of noise-sensitive lands are recommended to realize levels of less than 60 dBA (this is not a regulatory limit but the consensus of experts followed by USFWS). The analysis also takes into account that there are no Federal or CEQA guidelines for vibrations with regard to tunnel and conveyance facility construction, and hence reasonable methods need to be used for the effects analysis. Long-term operation of conveyance facilities should consider operations during daytime (7 a.m. to 10 p.m., recommended limit < 50 dBA) and nighttime (10 p.m. to 7 a.m., < 45 dBA) hours.

Conversely, the FHWA and FTA have developed methods to evaluate construction noise, which is used in this chapter, although the FHWA does not recommend specific limits for dBA. Rules of thumb commonly used for DWR projects based on the State of California protocols have been used in the analysis of Draft BDCP Alternatives and in recommending mitigation measures (e.g., construction of noise barriers). The No Action Alternative includes continued implementation of SWP/CVP until 2060 and hence the effects are similar to that of the present day.

III. Quality of Analysis

Almost all cited literature is from reports and websites, but given the laborious nature and complexity of the analysis, the coverage is acceptable. Standard noise assessment models are used, and potential (temporary) construction noise levels were assessed using the methodology developed by FTA (2006), assuming usage of standard construction machinery and associated noise levels and exposure. The Traffic Noise Modeling Lookup (TNM) model of FHWA was employed to estimate average noise levels at fixed distances from the roadway centerline based on estimated traffic volumes, types and densities. The model was programmed to produce a conservative, worst-hour estimate of traffic-generated noise levels due to heavy truck and increased commuter trips associated with construction of project and program components (Chapter 3). Some of the key aspects excluded in modeling that will have serious impacts on the project are the nocturnal atmospheric boundary layer effects and the influence of terrain and built up areas.

The following comments are offered for further consideration:

- A Noise Abatement Plan (Appendix 3B, *Environmental Commitments*) will be in place during construction to avoid or minimize adverse effects. In this construction plan, the contractors are required to limit off-site trucking activities (e.g., deliveries, export of materials, etc.) to 6:00 a.m. to 10:00 p.m. to minimize impacts to nearby residences. Recent studies, however, show that in the evening period, after the atmospheric stable stratification develops (Ovenden et al., *J. Acous. Soc. Am*., 232, 1124-1237), nearby communities become more vulnerable to excessive noise levels because of downward refraction of sound waves. An earlier termination of trucking and construction activities should be considered. This is also applicable for selecting noise-sensitive land sites for siting conveyance facilities.
- Noise monitoring at specific locations of construction has not been mentioned in the DEIR/DEIS, but is recommended considering that in-situ monitoring levels can be much different than the general levels given in chapter section 23.1. Monitoring of noise during different seasons ought to be considered, considering seasonal sensitivity.
- Mitigation of noise to an acceptable level may not possible in some cases, especially during construction. Thus, more attention should be paid to long-term operations, reckoning for which can be done for different times of the day and for different climatological conditions.
- The TNM Model does not take into account the terrain and buildings, and hence noise estimates must be treated with caution when clusters of buildings and above/below grade roadways are present.

For construction activities in areas close to freeway or cities, the assumed background condition of 40 dBA is unacceptable.

CHAPTER 25: PUBLIC HEALTH

I. Overall Assessment

There are some topics in Chapter 25 that are useful in evaluating the effects of the various Alternatives and conservation measures. However, we have concerns about several sections of Chapter 25, including the potential toxicity of certain algal species (e.g. *Microcystis*), the biomagnification of toxic substances (e.g. EMF), vector control issues (mosquitos), and disinfection by-products and contaminants. A detailed section is dedicated to each of those topics below with suggestions and recommendations to include in the DEIR/DEIS going forward.

II. Scope

Chapter 25 focuses on issues related to human health and safety that could potentially be affected by implementation of the Draft BDCP Alternatives. Topics covered include water quality, water borne illness, creation of habitat for vectors that may carry human and animal diseases, and concerns related to creation of additional electric transmission lines needed under most of the Alternatives. Specifically, the chapter deals with drinking water quality as related specifically to humans, bioaccumulation of toxicants in fish and aquatic organisms that are consumed by humans, pathogens in recreational waters, disease-carrying mosquitoes as vectors of human and animal diseases, and electromagnetic fields from transmission lines. Some of these topics are also included in other chapters in the DEIR/DEIS but pathogens in recreational waters and disease-carrying vectors are not addressed in any other chapters.

III. Quality of Analysis

<u>Completeness of impacts addressed</u>

Although the list of topics appears to be complete, additional material should be provided in the Final DEIR/DEIS on some of the topics covered, including potential toxicity of certain algae, biomagnification of toxic substances, control of potential vectors of disease, and consequences of water disinfection by-products. These are described below.

<u>Potential toxicity of certain algal species</u>

Potential toxicity of *Microcystis*, a genus of freshwater blue-green algae that can form cyanobacterial blooms, is a problem of both public health and ecological concern in the Delta. There is a large discrepancy in coverage of this topic in the Draft BDCP and the DEIR/DEIS. In general, *Microcystis* is mentioned infrequently and without detail in the DEIR/DEIS. Moreover, a qualitative analysis of the effects of *Microcystis* described in the DEIR/DEIS indicates that in the majority of cases, neither the public health nor the ecological consequences is even mentioned. In contrast, in the Draft BDCP, there is detailed coverage of this topic, and in the majority of cases the potential effects are highlighted. Most of the mentions (>10% of those found) of *Microcystis* in the DEIR/DEIS are in the appendices, whereas >30% in the Draft BDCP are in the text. This discrepancy in coverage is a major shortcoming in terms of effectively evaluating effects of the Alternatives and the conservation measures in this chapter in the DEIR/DEIS (as in other chapters as well). Moreover, in the Effects Analysis review presentation held on 28 January 2014, the issue of algal blooms was identified as a major potential impact in the Delta.

Biomagnification of toxic substances

In terms of the discussion on Biomagnification of Fish and Shellfish (page 25-8), the presentation of recommendations in a summary Table (Table 25-2. Advisories for Consumption of Fish and Invertebrate Species/Guilds for Each Waterway) seems to be an inadequate way of dealing with this problem of public health concern. Are these advisories on fish and shellfish consumption the only solution when biomagnification of toxics is acknowledged as a potential problem? Moreover, biomagnification is related to issues of environmental justice, in that people with lower income levels are likely to eat more fish and shellfish in the Delta region. Therefore, the biomagnification issue should be also discussed in Chapter 28.

There is an extensive discussion of EMF impacts: (page 25-22, lines 39-43). However, there is also the statement that "There has been extensive research done over the past 20 years on the relationship of EMF exposure and human health risks. To date, the potential health risk caused by EMF exposure remains unknown and inconclusive. Two national research organizations (the National Research Council and the National Institute of Health) have concluded that there is no strong evidence showing that EMF exposures pose a health risk."
If the perceived danger represents scientific misunderstanding on the part of some of the public, why isn't more attention in the document directed at correcting this misinformation by providing additional evidence and up-to-date information?

Vector Control

Several issues related to vector control need to be better addressed. For example, creation of potential mosquito habitats will not just have localized effects, as indicated in the DEIR/DEIS. Chapter 25 states that "Potential public health impacts occurring as a result of the Draft BDCP Alternatives primarily would be localized. Given downstream flows, potential health effects from water quality-related impacts would not be transported upstream" (page 25-2 lines 25-27); see also "Potential spread of disease through mosquitoes is expected to occur only within the study area because of the life cycle of mosquitoes and the distance they travel" (page 25-2 lines 30-32). In the case of these water-borne vectors of disease, these statements are not correct as these newly created habitats could serve as "stepping stones" for upstream migration of adult mosquitoes and eventually lead to their colonization of new sources. The California state Mosquito Abatement districts would be aware of this possibility and likely would disagree with the statements in the DEIR/DEIS as well. Objections to this statement in the DEIR/DEIS are also reinforced by the distances that are reported for mosquito migration in Table 25-5, where it is stated that mosquito adults can travel up to 30 miles.

There are no concrete plans presented for controlling mosquitoes when their populations increase. Clearly, this is being left to the future and the activities (which are already overstretched) of the local Mosquito Abatement districts. As stated in the DEIR/DEIS, "Construction of the water conveyance facilities and water supply operations under all Action Alternatives would result in an increase in sedimentation basins and solids lagoons. These new features could result in an increase in standing water, thereby potentially increasing vector breeding locations and vector-borne diseases in the study area." (page 25-34, lines 18-21). This statement is correct, and implementing proposed measures under most Alternatives would increase the amounts of restored and enhanced habitat in the study area, but also would result in a significant increase in mosquitoes. The conclusion is that BDCP would consult and coordinate with the various mosquito abatement districts to implement Best Management Practices (BMPs)

(as is also mentioned in section 31.5.1.3). Several of these BMPs are mentioned from various wetland-mosquito management documents. Is this sufficient coverage of control activities in the DEIR/DEIS in terms of what could be major public heath outbreaks (e.g. West Nile virus and encephalitis)?

The potential costs of nuisance mosquitoes are not discussed in this chapter of the DEIR/DEIS. Decline of home prices, loss of recreational areas and opportunities, and increased human discomfort from increases and expansion of mosquito populations could result. These could have environmental consequences as a result of public dissatisfaction and decreased regard for appropriate behavior in sensitive ecological areas. Inappropriate pesticide use could also increase. Moreover, under section 25-4, “Cumulative Analysis Problems of Disease,” vectors are not mentioned in the analysis. References on vector control are representative of a few studies done within the Delta but far from complete.

As with many of the other chapters, there is ambiguity in wording in many parts of Chapter 25. For example, "The availability of preferable mosquito breeding habitat varies by season, and is reduced during dry periods of the year. Available open water habitat can be expected to increase during wet season; however, changes in flow volume in the Delta would result in increased flow velocities, limiting preferable mosquito breeding habitat." (page 25-16, lines 11-15). If the statement means that changes in flow volume during the wet season would not affect the mosquito populations, it would be correct because breeding is minimal at this time of the year. However, if it refers to changes in flow volume during the dry season when mosquito breeding does occur, the statement is incorrect and actually numbers would increase.

Disinfection by-products and contaminants

Specific results and comparisons for disinfection by-products (DBP) are not discussed adequately. In terms of DBP, there are two important considerations that require additional information and clarity in the document: the water system management aspects and the direct public health aspects. The fundamental question that Chapter 25 does not seem to answer adequately is: What are the effects of the Alternatives on the actual changes in dissolved organic carbon and bromide concentrations in the source water, and how does that correspond to changes in DBPs in water delivered to the public after treatment by agencies using the source water? In this chapter, bromide receives far greater coverage than dissolved organic carbon, although the latter may have a significant impact on the formation of DBPs such as TTHMs and HAA5. There are indications that because of the increased variability of concentrations, bromide could increase as much as 43% in some locations, and in the case of drought, these concentrations could be much higher (perhaps almost double). The changes in dissolved organic carbon compounds, which are also a problem, are difficult to tell from the information provided. The combination of the changes in both total organic carbon and bromide under specific Draft BDCP Alternatives and on a temporal basis are important to understanding the impact on DBP formation after treatment.

Moreover, have the potential effects of extended drought periods been considered? These could aggravate the effects of these compounds because temperature and pH (moderated by algal activity) can affect DBP formation, and TTHM and HAA5 are measured on a running annual average basis using quarterly samples. Of note, the term “bromated” is used throughout Chapter 25, and we presume they mean “bromate”?

Agencies are required to be below Maximum Contaminant Levels (MCL) of DBPs. Depending on the Alternative chosen, agencies may be required to modify their treatment

processes, with potential large increases in cost. It is stated on page 25-52 that “While treatment technologies sufficient to achieve the necessary bromide removal exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.” No mention is made as to how these additional costs will be covered; will they be passed on to their consumers? Or is there a mechanism within the Draft BDCP to cover these increased costs of the agencies?

It is also not clear what the overall effect of increased DBP concentrations may have on public health. If it’s, say, a few percent, the effect may not be significant. However, MCLs for TTHMs and HAA5 are based on the sum of individual compounds, and an increase in some of the individual component compounds could have potential public health effects. For example some of the brominated analogs, which may be produced in higher amounts when bromide increases in the source water, could have significant public health effects. Have models considered the effects on individual components? If so, it is not evident in this chapter.

Consequences of mercury accumulation, bioaccumulation of other toxic compounds, and fish contamination are not adequately presented in this chapter of the DEIR/DEIS. All of these topics are commonly discussed public health concerns for the Delta, and require more detailed coverage in the DEIR/DEIS. The literature is extensive in these areas and not adequately represented.

Pathogens

Please see comments above about potential toxicity of *Microcystis* algal blooms not being included in the DEIR/DEIS, and the apparent different coverage presented in the Draft BDCP.

Conclusion

Public health concerns are of great importance to people living in the Delta, those that use it for recreation and other purposes, and those occupying outlying areas that may be affected by the proposed activities in the Draft BDCP. Additional consideration of the issues mentioned in this review should be given in the preparation of the Final DEIR/DEIS document.

a) Is the literature from which the analysis builds appropriate?

Although perhaps considered adequate for fulfilling the conventions of the CEQA process, the importance of this document in guiding the direction of project activities should include the most up-to-date scientific information available. For example, references on vector control are representative of a few studies done within the Delta but far from complete. Moreover, virtually no peer reviewed literature is included. In addition, there is little reference to the extensive literature on toxic algal blooms, biomagnification, and water disinfection by-products in the Delta.

b) Are the formal models and/or broad patterns of reasoning relied upon the "best available"?

Specific results and comparisons for disinfection by-products are not discussed adequately in this chapter. For example, (page 25-2, lines 18-21) "The disinfection process for drinking water includes adding chlorine to drinking water sources prior to release into public drinking water distribution systems. The chlorine reacts with organic carbon (total [TOC] and dissolved [DOC]) and bromides that are in water sources and form DBPs." Concentrations of disinfection by-products precursors (bromides and DOC) have often been modeled for this system. As a result, there is considerable analysis capability available for some of these

contaminants that are not evident in this chapter nor is there adequate discussion of these potential impacts. This topic is very important and potential public health effects should be discussed more fully in Chapter 25.

c) Are the inputs (or other basic facts) to the models/reasoning the best available?

In terms of modeling, it's not clear what values were used in their analyses. Did they model raw water concentrations? Have they modeled these with values that would be present throughout the drinking water system after treatment? Were running averages used at specific locations representative of a distribution system (the current approach)?

d) Where modeling judgments and interpretive reasoning are invoked, are they appropriate?

Some of the brominated analogs, which may be produced in higher amounts when bromide increases in the source water, could have significant public health effects. Have models considered the effects on individual components?

e) Are the results and their uncertainties interpreted in a "balanced" way with respect to the strengths and weaknesses of the Alternatives under consideration?

The uncertainties do not seem to have been considered in reaching conclusions from the models used.

CHAPTER 26: MINERAL RESOURCES

I. Overall Assessment

Chapter 26 concludes that the proposed BDCP actions would cause harm to natural gas production while having less-than-significant effects on aggregate.

Most of the expected impact to gas production is from conservation measures that would inundate production areas (impacts MIN-5 and MIN-6). The chapter's assessment of the No-Action Alternative appears to exclude such gas-field losses to unintended flooding. The assessed impact on aggregate includes its consumption by BDCP construction as well as burial of potential aggregate sources.

A key aspect of this chapter that should be included but is missing is how natural gas impacts MIN-5 and MIN-6 affect feasibility of ecosystem restoration under proposed BDCP actions.

II. Scope

The chapter lays out its findings in muscular text that shows command of the subject, and in tabular summaries (Tables 26-4 through 26-7) that ease comparison among Alternatives. The chapter however, lacks an informative up-front summary, and neither the Highlights Document (page 57) nor the Executive Summary (pages ES-130 and ES-131) make up for its absence.

III. Quality of Analysis

Chapter 26 does not examine how natural gas impacts MIN-5 and MIN-6 may affect the feasibility of ecosystem restoration under proposed BDCP actions. Plan Appendix 8.A, "Implementation Costs Supporting Materials" lists mitigation measures: "Avoid displacement of active natural gas wells to the extent feasible through conservation component design" and "Maintain drilling access to natural wells to the extent feasible through design of conservation components" (page 8.A-164). Plan Chapter 8, "Implementation Costs," gives a 50-year estimate of $32 million for "mineral rights and gas-well relocation" (page 8-14). A search on "gas" in Appendix 8.A and Chapter 8 turned up no supporting evidence for the $32 million estimate.

CHAPTER 27: PALEONTOLOGY

I. Overall Assessment

Chapter 27 provides reasonable responses to the CEQA requirement for assessment of potential harm to fossils. The chapter includes an overview of paleontological resources in the Sacramento - San Joaquin Delta, Suisun Marsh, and vicinity, and it systematically estimates potential effects of the Draft BDCP Alternatives on paleontological resources. Two DISB members evaluated the chapter with help from a vertebrate paleontologist. Together we identified several areas of concern: more attention needs to be given to deposits from recent millenniums; sensitive geologic units should not be used as a source of “borrow material”; different counties, communities, cities, etc. have different requirements for paleontological resources; the same protection should be in place for all areas of high and medium paleontological sensitivity; the primary source for levee failure is unknown; and a strong summary should be placed at the beginning of this chapter.

II. Scope

The chapter considers the potential impacts to fossils, especially of vertebrates, from disturbing the ground during construction for CM1 (water conveyance; impact PALEO-1) and for other conservation measures (habitat; impact PALEO-2). The chapter also considers such impacts from other projects that are likely to cause ground disturbance (under the No-Action Alternative). The chapter finds "significant" impacts in all three cases.

The findings are based on reasonable assumptions about what might turn up in excavations. In some areas the digging would reach sedimentary deposits old enough (Pleistocene and earlier) to be considered "paleontologically sensitive" (defined, page 27-6). Macroscopic plant and animal fossils in these deposits are likely to be rare enough to be considered important (page 27-18) as "records of ancient life" (page 27-30).

The sensitivity ratings are typically based on (1) the potential for a geological unit to yield abundant or significant vertebrate fossils or to yield a few significant fossils, large or small, vertebrate, invertebrate, or paleobotanical remains; and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecological, or stratigraphic data (which are criteria of the Society of Vertebrate Paleontology). The ratings range from none to high. Chapter 27 states that this full range is present in the area covered by the BDCP conservation measures.

Such paleontological assessments involve a professional paleontologist examining the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may be germane to fossil preservation and potential yield.

The chapter shows greatest concern for the fossils of vertebrates. The chapter treats vertebrates as the most important fossils to be expected in the Pleistocene alluvial deposits that border much of the Delta, and which extend at shallow depths beneath it. The mitigation measures specify procedures of the Society of Vertebrate Paleontology.

The chapter proposes paleontological mitigation of the BDCP conservation measures. The mitigation efforts involve planning and training meant to encourage identification, collection, and preservation of important fossils unearthed (first spelled out, pages 27-27 to 27-32). The tabular summary, pages ES-131 and ES-132, states that these efforts would reduce, to "less than significant," the effects of conveyance construction for Action Alternative 9 (which

restricts conveyance to existing channels) and the effects of all habitat construction under all the action Alternatives.

III. Quality of Analysis

How valuable are the fossils in Holocene mud and peat?

The chapter states fair reasons to give deposits from recent millennia little attention as paleontological resources. "Muds and peats [less than 10,000 years old] provide a rich source of microfossils for paleo-environmental studies, but microfossils exist in the uncounted trillions throughout deposits of estuarine mud and peat. Therefore, because they are recent in age and because they seldom yield scientifically significant megafossils, estuarine sediments, including peat, are assigned low paleontological sensitivity" (page 27-7 to 27-8).

Nonetheless, because climate change and ecosystem restoration are important in the DEIR/DEIS, Chapter 27 could say more about the paleoecology that has been inferred from Holocene fossils. These young fossils are guides to climatic change and to bygone ecosystems like those slated for restoration under the BDCP (Malamud-Roam et al., 2006; Canuel et al., 2009).

Will sensitive geologic units serve as sources of borrow material?

Stratigraphic units having undetermined to high paleontological sensitivity are present in some of the areas considered as potential sources for borrow material for construction activity. The vertebrate paleontologist advises against using these units, which include the Modesto Formation, Montezuma Formation, and Turlock Lake Alluvium, as sources for borrow material (Table 27-7).

If excavation into these units is common, Chapter 29 could give examples and mention paleontological discoveries that the digging has occasioned.

Will protections vary from one county to the next?

Unlike counties that have specific requirements for paleontological resources, Sacramento, Yolo, and San Joaquin Counties place emphasis on the preservation of historic and cultural values and on compliance with CEQA without specifically considering paleontological resources. If not made clear already, Chapter 27 could say whether as part of implementation, the BDCP would apply in all Delta counties the paleontological provisions of state and federal laws and the mitigation measures mentioned in Chapter 27.

What is the primary source for a statement about levee failure?

Chapter 27 reasonably identifies levee failure as a threat to paleontological resources. The evidence cited includes an unreferenced statement that "levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (page 27-22; reiterated from page 9-50). This statement could be credited to page 6-37 of a seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The citation could also mention that this assessment, on its page 6-36, includes calibration in which Delta levee damage from the 1906 San Francisco earthquake is "small to moderate" for levees having "today’s configuration." .

The chapter lacks a summary

Like most of the DEIR/DEIS, Chapter 27 needs an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and

text in the Highlights Brochure. A useful summary, placed up front, would build on the "overview" on page 58 of the Highlights Brochure. The summary would make clearer how the various Alternatives, including the No-Action Alternative, compare with one another in terms of effects on paleontological resources. The key comparisons include No-Action vs. Alternative 4.

The Executive Summary of the DEIR/DEIS could summarize the "significant" No-Action impact more accurately. Table ES-9 lists this impact in rows for PALEO-1 and PALEO-2, where it can be misread as a puzzling effect of BDCP actions. The table also can be misread as implying that the significant No-Action impacts would somehow be made less than significant through implementation of Alternative 9 (for impact PALEO-1) and of all Action Alternatives (for impact PALEO-2).

IV. References Cited

Canuel, E.A., Lerberg, E.J., Dickhut, R.M., Kuehl, S.A., Bianchi, T.S., and Wakeham, S.G., 2009, Changes in sediment and organic carbon accumulation in a highly-disturbed ecosystem: The Sacramento-San Joaquin River Delta (California, USA): Marine Pollution Bulletin, v. 59, page 154-163, doi:10.1016/j.marpolbul.2009.03.025.

Malamud-Roam, F., Ingram, B.L., Hughes, M., and Florsheim, J.L., 2006, Holocene paleoclimate records from a large California estuarine system and its watershed region; linking watershed climate and bay conditions: Quaternary Science Reviews, v. 25, page 1570-1598, doi:10.1016/j.quascirev.2005.11.012.

URS Corporation, and Jack R. Benjamin & Associates Inc., 2008, Delta Risk Management Strategy (DRMS), phase 1, risk analysis report, final: prepared for California Department of Water Resources, http://www.water.ca.gov/floodsafe/fessro/levees/drms/phase1_information.cfm.

CHAPTER 29: CLIMATE CHANGE

I. Overall Assessment

The Draft BDCP (and, in a less informative fashion, the DEIR/DEIS) does a good job of describing how climate change and sea-level rise might influence communities and species. The emphasis in Chapter 29 is on how the conservation measures of the Draft BDCP may enhance adaptation and resiliency to climate change and, especially, sea-level rise by providing flexibility in water-flow operations and additional conservation areas and habitat. Although any attempt to predict future climate at a relatively small regional scale is difficult at best, state-of-the-science modeling tools have been employed to project possible future conditions. Despite these efforts, climate change and sea-level rise, and their associated uncertainties, will remain. The likelihood and magnitude of these effects and uncertainties are not clearly stated or addressed.

Both the Draft BDCP and the DEIR/DEIS recognize the importance of the linkages that are created by water flows and hydrology. Synergies that result from linkages among the actions or components of the Draft BDCP, species of concern, or species not even considered, may affect the potential benefits derived from BDCP actions in enhancing adaptation and resiliency to the effects of climate change or sea-level rise, yet such synergistic effects (which may be either positive or negative) receive little attention.

From a biological viewpoint, mean climate conditions are not as important as high or low extremes and their timing. Modeling and analysis of extreme events is difficult because such occurrences are unpredictable and uncertain, yet their importance merits more attention. Moreover, the potential effects of climate change and sea-level rise on water temperatures seem not to have been considered at the same level of resolution as changes in salinities. Temperature, however, is a key to most fish growth and reproductive success.

Perhaps most importantly, the potential effects of climate change and sea-level rise *on* the effectiveness of the conservation measures themselves are not adequately considered. There is an underlying assumption that the conservation measures, if implemented, will have the desired or stated benefits or mitigation effectiveness. Because of the changing conditions, the Draft BDCP actions may not develop as anticipated. Uncertainties in the effectiveness of conservation measures due to the effects of climate change and sea-level rise should be given greater consideration.

II. Scope

Section 85320(b)(2)(C) of the California Water Code directs that the DEIR/DEIS address "[t]he potential effects of climate change, possible sea level rise up to 55 inches [140 centimeters], and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the [EIR]." This is the context for the treatment of climate change and sea-level rise in the DEIR/DEIS.

The DEIR/DEIS addresses three questions about climate change and sea-level rise: (1) How will the Draft BDCP activities affect climate change, via greenhouse gas emissions?; (2) How will Draft BDCP impacts on resources be affected by climate change and will the effects increase in the future — i.e., are future changes in climate likely to exacerbate project impacts?; and (3) How will the Draft BDCP activities affect the adaptability and resiliency of the Delta and its components to climate change? Question 1 is addressed in Chapter 22 on air quality and greenhouse gases. Question 2 is considered in most of the resource-focused chapters as summarized in Table 29-1 as well as in the Draft BDCP. Chapter 29 addresses only the third

question. In particular, this chapter concerns how the project Alternatives and conservation plans may enhance adaptation and resilience of the Delta system to changing rainfall, snowpack, water and air temperature, sea-level rise and intrusion, and evapotranspiration. In the context of BDCP, resiliency and adaptability mean "the ability of the Plan Area to remain stable or flexibly change, as the effects of climate change increase, in order to continue providing water supply benefits with sufficient water quality and supporting ecosystem conditions that maintain or enhance aquatic and terrestrial plant and animal species" (DEIR/DEIS page 29-3). The current unprecedented drought in California adds weight to any measures that will enhance adaptability and resilience of water use and management, so the focus of this chapter is especially timely.

Although Chapter 29 is relatively short, the overall consideration of climate change in the DEIR/DEIS and the Draft BDCP is comprehensive and voluminous, but also fragmented. Thus, to evaluate how well the DEIR/DEIS considers the broader issues of climate change and sea-level rise and their effects, we have referred to multiple sections of the DEIR/DEIS, and to understand the foundation for the statements and conclusions we have examined parts of the Draft BDCP where the details of modeling and analysis of climate change and sea-level rise and their consequences are presented.

III. Quality of Analysis

To evaluate how climate change relates to the actions envisioned in BDCP, it is first necessary to consider how it is projected to affect the Delta and its resources, independently of any of the conservation measures undertaken in the Draft BDCP (i.e., the No Action Alternative). Various sections of the Draft BDCP and the DEIR/DEIS (particularly Draft BDCP Appendix 2C and DEIR/DEIS sections 29-4 and 29-5) describe the changes expected in California and in the Delta over the coming decades. These effects will be large and pervasive, creating a dynamically changing backdrop against which any environmental effects of the Draft BDCP will be superimposed.

Overall, the effects of the climate changes expected for the Delta include, among others: (1) increased incidences of extreme hydrologic events such as atmospheric rivers (which provide significant precipitation to the Delta); (2) changing the mix and timing of rain and snow and their locations; (3) increased extinction risk of covered fish species, especially those whose ranges are located primarily in the Draft BDCP area, due to changes in critical temperatures, salinities, and flow regimes; (4) continuing emergence of nonnative species (e.g., warm-water species) as dominant components of biological communities; (5) increased risk of species invasions due to range expansions into the region; (6) changes in sea level and salinity, which may cause increased duration and frequency of inundation of the existing wetlands; and (7) somewhat higher salinities in Suisun Bay, requiring increased Delta outflows to maintain X2 at the existing standard (Draft BDCP page 5.A.2-106-107). Although all of the natural communities and covered species will be affected in some way, the focus in the DEIR/DEIS is on long-term changes in sea level and Delta inflows that "will put increasing stresses on existing levees and make management of Delta salinity increasingly difficult" (DEIR/DEIS page 3E-3) and the increased flexibility the Draft BDCP offers to control flow rates.

The potential impacts of climate change on natural communities and covered species are discussed in detail in the Draft BDCP (especially in Chapter 2, Appendix 2A, Chapter 5, and Appendix 5A). For example, the account for Delta Smelt states that "modeling results projected increases in the number of days with lethal and stressful water temperatures (especially along the Sacramento River) and a shift in thermal conditions for spawning to earlier in the year, upstream

movement of the LSZ, and decreasing habitat suitability" (Draft BDCP page 2A.1-12). These accounts, while necessarily qualitative rather than quantitative, are generally comprehensive and well-referenced.

Draft BDCP contributions to resilience and adaptability

Chapter 29 focuses on how the actions undertaken as part of the conservation measures or mitigation for BDCP might help counter some of the effects of climate change on natural communities and covered species. In essence, the DEIR/DEIS proposes that the Draft BDCP will enhance the adaptation and resilience of the Draft BDCP area by: (1) providing the flexibility in operating water flows to ameliorate conditions caused by climate change, and (2) enabling conservation efforts (CM2 – CM22) that will provide additional habitats or protection of key species that will help to offset any negative climate impacts. The benefits derive largely from the enhanced control and flexibility in managing hydrological flows into and through the Delta provided by the conveyance Alternatives and, to a lesser extent, from the increase in quantity and/or quality of habitat created by the restoration or protection measures. For example, for tricolored blackbirds "protection, restoration, and enhancement of nesting and foraging habitat will help stabilize and increase depleted populations, helping to promote resilience to adverse effects of climate change" (Draft BDCP page5.A.1-28). Appendix 5.A.1 and Table 5.A.2.0-1 of the Draft BDCP provide substantial details describing which actions can enhance resilience or adaptability to climate change and sea-level rise. The benefits, while generally based on relevant literature and logical arguments, are *presumed* (or, perhaps more accurately, hoped-for) benefits; there is no assurance that they will develop as expected, and there is no discussion of what, if anything, will or can be done if they do not develop. That is, what adaptive management measures will be taken? The conclusion is that Draft BDCP Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, and 5 would provide substantial resiliency and adaptation benefits over the No Action/No Project Alternative for dealing with the combined effect of increases in sea-level rise and changes in upstream hydrology. The other Alternatives would reduce resilience. Appendices 29A – 29C describe the approach to modeling and analyzing salinity effects, effects on reservoirs and inflows to the Delta, and effects on water and air temperatures.

The chapter explicitly does not include any discussion of impacts (although recognized and listed on pages 29-10 and 29-11) for which the Draft BDCP Alternatives produce no added resiliency or adaptation benefit or for which the benefits are minimal or cannot be documented; the emphasis is on potential benefits of the Draft BDCP.

Assessment of effects

The potential effects of climate change and, particularly, sea-level rise receive a comprehensive, detailed, and scientifically sound treatment when considered over the entirety of the DEIR/DEIS and the Draft BDCP. The effects on the key physical and biological components of the Draft BDCP area, and somewhat on the broader Delta ecosystem, are thoroughly discussed. Most of the relevant information is contained in the Draft BDCP. The DEIR/DEIS is inconsistent in the level of detail used to assess impacts of climate change and sea-level rise on these components and the information is scattered over thousands of pages, making it difficult to evaluate how they have been treated.

Any science-based assessment of climate change and its effects necessarily begins with historical data and predictive models. Modeling climate change at the regional scale is becoming

more robust, particularly when dealing with mean conditions or frequencies of extremes. The modeling approach used to assess climate change and sea-level rise in the Draft BDCP is complex, necessarily involving many assumptions and a nesting of models used in sequence to inform one another. The climate modeling is based on a modified ensemble approach, employing a quantile analysis to condense the results of the 112 downscaled model sets into a smaller set of scenarios that emphasizes mean climate conditions while preserving some of the variability among model runs (described in the DEIR/DEIS on pages 5A-D37-38). The approach intentionally uses a subset of scenarios to allow development of projections in greater detail, while sacrificing a more comprehensive assessment of uncertainties that would come from considering the full range of projection scenarios. This is a robust and appropriate approach. The criteria used to select the set of climate change scenarios for the analyses (DEIR/DEIS page 5A-A62; 5A-D33) seem sensible, and the sensitivity analysis approach used to define the boundaries for ensemble predictions (DEIR/DEIS page 5A-A64) is canonical, especially in incorporating the effects of different starting points for the simulations. The potential importance of extreme events is acknowledged but, in view of their unpredictability, they are not included in the modeling (although they could be incorporated into probabilistic modeling). Instead, any unforeseen effects of extreme events will presumably be assessed through monitoring and adaptive management. The application of results to the biological communities requires additional assumptions. Also, use of mean conditions or forecasts is far less insightful than looking at critical biological factors such as summer high temperatures, rate and timing of spring warming and fall cooling, and flow rates during critical times of the years. One extreme year can do a lot of biological damage.

The RMA Bay-Delta (2D) and the UnTRIM Bay-Delta (3D) hydrodynamic models were used to simulate climate change effects of sea-level rise on Bay-Delta tidal flows, which were combined with DSM-2 for salinity modeling. These were then combined with Draft BDCP effects to simulate future Delta hydrodynamic and salinity conditions. To bracket the range of potential changes in hydrodynamics and salinities associated with wetland restoration, model simulations were conducted for several Alternative restoration footprints. Changing the location of restoration affected the details of flows and salinities, but all of the scenarios reduced tidal amplitude and affected salinity (X2). Overall, the hydrological modeling shows that effects of Draft BDCP operations and proposed restorations are limited in comparison to the impacts of climate change and sea-level rise on upstream reservoir conditions, hydrologic flows, and salinities. Several of the outstanding areas of uncertainty are (quite appropriately) explored through scenario analysis.

Recognizing that species differ in their responses to potential climate change, the Draft BDCP develops a vulnerability score based on sensitivity (including several contributing factors) and exposure (defined by natural community types). The vulnerability analysis would allow planners and managers to design conservation actions and monitoring programs to enable them to focus on the covered species most vulnerable to the effects of climate change and the habitats that support a large number of vulnerable species (see Draft BDCP page 5.A.1-35). However, because different species respond differently to various climate changes, some will be affected by things that can be moderated and some will be affected by things that cannot be modified. For those in the first category, each operation might benefit each species a little differently; how will choices be made? Moreover, while listing the species most vulnerable to changes in climate is an important step toward prioritizing conservation actions, we should not forget that we are dealing with an ecosystem and indirect effects of climate change (changes in rates, distributions, species

interactions, food webs, etc.) are also important. Despite the attention given to developing species' vulnerability scores in the Draft BDCP, it does not figure into any of the analyses or documentations in the Draft BDCP and is not mentioned in the DEIR/DEIS.

Overall, considering the material in both the Draft BDCP and the DEIR/DEIS, the potential effects of climate change and sea-level rise on components of the Delta ecosystem and the current and proposed water operations are treated comprehensively and in considerable detail. Points are supported by relevant literature (at least in the Draft BDCP), some of it quite recent. The models are carefully reasoned and are used effectively to explore both consequences of climate change and sea-level rise and important areas of uncertainty. That said, however, there are several areas in which the presentation and analyses could be improved.

Areas of concern

There are several areas of concern with the treatment of climate change in the DEIS/DEIR that are not resolved in the coverage in the Draft BDCP.

Most importantly, although the potential effects of climate change and sea-level rise on natural communities and covered species are discussed in detail (in the Draft BDCP) and are included in the modeling of hydrodynamics and the associated tidal wetland restoration and in the discussion of reservoir operations, the possible impacts *on* the conservation measures are apparently not considered. The DEIR/DEIS includes detailed calculations of the anticipated losses of habitat (acreages) due to various Draft BDCP actions and how these losses will be balanced (in most cases exceeded) by acres of habitat (often of greater value) protected or restored. In some instances, additional measures (Avoidance or Minimization Measures or Mitigation Measures) will be required to achieve the necessary balance and avoid detrimental effects on a community or species. There is an unstated assumption that the anticipated habitat protection, restoration, and mitigation will in fact materialize. But climate change is projected to have significant effects on the amount, quality, and locations of habitat, potentially adding to the losses. The effectiveness of habitat protection and restoration may be compromised by climate change or sea-level rise, eroding (figuratively and literally) the conservation gains or benefiting less desirable species such as warm-water predators or invasive species. As a result, the anticipated balancing of new conservation areas to offset climate impacts and the Draft BDCP may not develop as planned.

It is possible that these effects are included in the calculations of the DEIR/DEIS (e.g., in Chapter 12), but we found no indications of such adjustments. Rather, it seems apparent that the potential effects of climate change and sea-level rise on the effectiveness of habitat protection, restoration, or other conservation measures are not specifically addressed in the DEIR/DEIS because the intent of this document is to evaluate whether BDCP will lead to consequences that would not otherwise have occurred (this is why the effects of climate change and sea-level rise are included in the No-Action Alternative). Draft BDCP actions will not alter climate change or sea-level rise (Chapter 23); rather, the effects of climate change and sea-level rise are projected to trump any effects of Draft BDCP actions. For example, "The results [of hydrological modeling] show that the effects on the upstream operations are primarily due to the climate change effect on the reservoir inflows, river temperatures, and the increased salinity intrusion in the Delta due to the projected sea level rise. The proposed BDCP operations did not impact the upstream reservoir conditions, both at end-of-May and end-of-September, because of the increased flexibility in the system [i.e., resilience]. The proposed restoration under BDCP has limited effect on the overall system operations" (Draft BDCP page 5A-D157). Considering that

the overall rainfall levels at reservoirs are projected to be essentially unchanged but the timing of snow and precipitation will change, there is little doubt that additional Draft BDCP conveyance and storage capacity would be useful in managing water in the Delta, but without including such adaptive management measures in modeling it will be difficult to predict the salinity and temperature levels as well as impacts on habitats downstream.

There are also considerable uncertainties associated with any potential effects of climate change and sea-level rise on Draft BDCP actions. This is used as justification for not considering these effects in the DEIR/DEIS. To ignore these potential effects on the conservation measures (primarily habitat protection and restoration) that are intended to be part of achieving net benefits from BDCP, however, may be short-sighted. It is anticipated that any failures of protection and restoration (or other actions) to realize the desired outcomes will be detected by monitoring and adjusted through adaptive management. However, this relies on how well and how quickly monitoring and adaptive management can or will be implemented. We consider this issue, and the wisdom of planning for contingencies in case things don't work out as planned, elsewhere in our report.

A second concern has to do with linkages. What happens or is done at one place and time for one species, for example, may have ripple effects that extend to other places at other times and affect other species. Climate change and sea-level rise will likely affect everything in and surrounding the Delta, everywhere, in one way or another. The scope of climate change as a driving force is broad in both space and time, although the consequences may be more localized and short-term or episodic. Consequently, considering the effects of climate change or calculating the potential benefits derived from separate Draft BDCP actions in enhancing the resiliency of each ecosystem component separately may fail to recognize the synergies that result from the linkages among the actions or components, species of concern, or species not even considered. Although the web of direct and indirect linkages among components of the Delta ecosystem are tremendously complex (and therefore plagued by uncertainties), it would be worthwhile to give them more thought, particularly because recognizing linkages and feedbacks may make management actions more effective or avoid unintended consequences. Both the Draft BDCP and the DEIR/DEIS recognize the importance of the linkages that are created by water flows and hydrology; similar attention should be given to biological, physical, and chemical linkages between aquatic and terrestrial elements or among elements of terrestrial landscapes.

A third concern is about modeling. A chain of models has been used to predict the 2025/2060 hydrology, salinity, and water temperature. As pointed out above, however, the influence of local adaptive management measures can have an upscaling effect system-wide. The models used are well studied and evaluated, but sometimes they lack critical components. For example, the CALSIM-2 runoff model does not have a good linkage to ground water, the mixing parameterizations used are not valid for very high flow rates (model calibrations may not be applied for extreme precipitations of future climate), and the DSM2 flow-salinity relations may not be valid for extreme future climate scenarios. Thus, uncertainties abound.

Finally, two additional points regarding mean conditions and temperature, and regional influences of climate change. First, there is some discussion in both the Draft BDCP and the DEIR/DEIS about the changes in mean conditions, particularly changes in mean temperature. However, what may be most important to fish (and other aquatic organisms), particularly for those species living on the edge of their thermal tolerance, are increases in the highest temperatures. The timings of the increased temperatures and of the fall cooling are also

important to aquatic organisms. Some species may benefit from the longer, warmer growing season while others will be stressed by a longer period of warmer temperatures.

Second, although Chapter 29 deals mainly with flexibility of water-flow operations and does include climate impacts on physical conditions (e.g. precipitation and sea-level rise) outside of the Draft BDCP area, it ignores potential regional influences of climate change on biological components elsewhere. For example, the survival of anadromous fishes in the ocean or during their migrations to and from the Delta will be affected by climate changes, and range expansions or distributional shifts of species in response to climate-driven habitat changes elsewhere may have impacts on species and communities within the Draft BDCP area, and on the effectiveness of conservation measures undertaken to enhance their populations or mitigate the effects of Draft BDCP actions. While such effects are couched in uncertainty, they should not be ignored.

CHAPTER 30: GROWTH INDUCEMENT AND OTHER INDIRECT EFFECTS

I. Overall Assessment

The material in this chapter is fairly comprehensive with respect to cities, but ignores how the Draft BDCP affects or does not affect the growth of agriculture, any crop changes, and any environmental changes those impacts would entail. With respect to cities, the analyses are interesting, and there is more than enough material to provide more insightful interpretation, for example with respect to uncertainties, than the authors chose to do.

II. Scope

Chapter 30 explores the extent to which the Draft BDCP might induce economic growth through: 1) tunnel construction expenditures on labor and thereby on housing, etc. in the Delta region; 2) the construction of new or better roads in the process of tunneling in the Delta; and 3) through the effects of increased water deliveries or simply increased reliability of water deliveries for municipalities and industry in the water delivery areas as well as agriculture. The latter, however, is not actually explored on the argument that the environmental impacts with respect to which crops would be planted under different scenarios and operation plans would be too speculative and therefore beyond scientific analysis (see, for example, page 111, lines 6-12).

III. Quality of Analysis

A fairly simple accounting framework was used to project population growth effects based on existing projections of population growth, per capita water use, expected improvements in efficiency, and how additional on account of the Draft BDCP, or less if no actions are taken, water could accommodate more population growth. These are highly likely to be over estimates of the population growth inducing potential of more water, or greater reliability, due to numerous other factors promoting and constraining growth including the need for improved wastewater treatment facilities, transportation limitations, etc. No error bars, not even subjective ones, are provided, though the results are presented fairly cautiously.

Construction is not likely to induce growth because little labor will be employed. Further, there is little available nearby housing in the Delta, nor special attraction to living near the job site, while the small increase in labor and need for housing would be insignificant for the larger outlying cities.

Whether or not the Draft BDCP will induce further population growth in municipal areas served by the SWP depends on which Alternative and operation plan is selected. The projected increases, and sometimes decreases, as a percent of already projected growth, are typically insignificant except for the South Coast Basin served by MWD. Here, under some plans, population increases due to increased water deliveries (for Alternative 3) could be as high as 14% of existing projected population increases and 19% of the projected population increase compared to the No-Action Alternative, where municipalities would experience reductions in water deliveries from the SWP.

The chapter explores the various possibilities of how water could induce population growth in considerable detail, considers the linkages between population growth and economic growth, and also provides a thorough investigation of municipal and county planning processes for accommodating growth while reducing environmental impacts, mostly in the South Coast Basin where the impacts could be significant.

Chapter 30 also lays out which agencies are in charge of growth and its environmental impacts, especially in the South Coast Basin, making it very clear that it is up to them to deal with the problems and not the responsibilities of DWR or USBR or other State and Federal agencies. Furthermore, the chapter is informative for local and regional planning agencies. The DWR and USBR do not have the authority to deny going forward on the Draft BDCP because of any induced growth.