San Luis & Delta-Mendota Water Authority

P.O. Box 2157
Los Banos, CA 93635
Phone: (209) 826-9696
Fax: (209) 826-9698

Westlands Water District

3130 N. Fresno St
P.O. Box 6056
Fresno, CA 93703-6056
Phone: (559) 224-1523
Fax: (559) 241-6277

March 17, 2017

VIA ELECTRONIC MAIL ONLY

State Water Resources Control Board
Attn: Jeanine Townsend, Clerk to the Board
1001 I Street, 24th Floor
Sacramento, CA 95814-0100
E-Mail: commentletters@waterboards.ca.gov

Re: 2016 Bay-Delta Plan Phase 1 Amendment and Substitute Environmental Document

Dear Members of the State Water Resources Control Board:

The San Luis & Delta-Mendota Water Authority ("Authority") and Westlands Water District ("Westlands") (herein "Public Water Agencies"), appreciate this opportunity to provide comments on: (1) the proposed Southern Delta Agricultural Water Quality Objectives ("Proposed Salinity Objective"), proposed Lower San Joaquin River Fish and Wildlife Flow Objectives ("Proposed Flow Objective"), and the proposed Program of Implementation for those objectives, and (2) the Recirculated Draft Substitute Environmental Document ("Draft SED") in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary ("Bay-Delta Plan"): San Joaquin River Flows and Southern Delta Water Quality.

After many decades of managing the ecosystem primarily by regulating the storage, release and diversion of water – the flow of water – a new approach is necessary. Under the existing flow-centric approach, which relies upon flow as the master variable and master solution, few beneficial uses of the water involved have been adequately protected. The diagnostic inertia of the current flow-centric regulatory regime has had real, adverse social and economic impacts. Fish populations and water supplies for urban and agricultural communities and waterfowl have all declined. The painful lessons of the past twenty years have demonstrated that adding flow will not redress most of the physical, chemical and biological changes that have occurred within the watersheds for the Sacramento and San Joaquin Rivers.

The State Water Resources Control Board's process to update the Bay-Delta Plan presents an important opportunity to, , at least question and at best replace the existing, failed regulatory regime. This process presents an opportunity to move toward a more scientifically-sound approach that provides flow when it will serve specific functions and that better supports an improved understanding of the biological mechanisms impaired by the physical, chemical

and biological changes that have occurred within the watershed. Two examples of the many pieces of scientific literature that supports the functional flow approach are:

- Flows and Fishes in the Sacramento-San Joaquin Delta, A Review by the Delta Independent Science Board, August 2015, in which independent scientists recommend a "Focus on cause and effect - the mechanisms that enable flows to affect fishes."[1]

- Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities, Yarbekk et al., BioScience Advance Access, August 5, 2015, in which the authors recognize that "[m]imicking a natural flow regime in modified riverscapes will not yield successful ecological outcomes unless such flows trigger functional processes" and therefore "propose that a more effective approach is to identify and restore aspects of the flow regime that support key ecosystem functions and drive geomorphological and ecological processes."[2]

Unfortunately, the Proposed Flow Objective and Draft SED do not take advantage of the opportunity presented. The Proposed Flow Objective and Draft SED do not take advantage of the significant scientific body of information and increasingly sophisticated monitoring tool developed since the last meaningful update to the Bay-Delta Plan. And, nowhere does the Draft SED explain why the State Water Board should stray from the scientifically-sound functional flow approach. Indeed, nowhere does the Draft SED present analysis showing the level of protection that is expected if the State Water Board continues with a flow-based regulatory approach, particularly based on a percent of unimpaired flow, or the relative benefit of that approach compared with a "functional flow" approach.

Consistent with the significant body of scientific literature that recognizes the benefits of a functional flow approach in a highly altered system such as the Bay-Delta, the Delta Independent Science Board recently identified defects within the draft scientific basis report for the Phase 2 proceedings.[3] Three of the defects are:

- **Failure To Explain The Basis For And Implementation Of The "Unimpaired Flow" Approach**: The independent scientists wrote: "we recommend clarifying, and further justifying scientifically, the proposed use of percent of 'unimpaired flow' as the main basis for establishing an annual environmental water budget." (DSB Review Letter, at 1.) The independent scientists also wrote: "the proposed approach would establish a fixed annual volume of water to be used for environmental purposes…. It would be useful for the report to separately clarify a) how the fixed annual quantity of water would

[1] Available at http://deltacouncil.ca.gov/sites/default/files/2015/09/2015-9-29-15-0929-Final-Fishes-and-Flows-in-the-Delta.pdf.

[2] Available at https://academic.oup.com/bioscience/article/65/10/963/245807/Functional-Flows-in-Modified-Riverscapes.

[3] The Delta Independent Science Board letter raising the comments ("DSB Review Letter") is attached hereto and incorporated herein by this reference. It is also available at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/environmental_review/docs/cmp_rvw_cmmnt_isb/20170228_disb_report.pdf.

be used, with and without successful agreements among basin water managers and b) how the annual water volumes would be calculated (by basin and/or by tributary)." (DSB Review Letter, at 2.)

- **Failure To Adequately Consider Alternatives**: The independent scientists wrote: "The report could be improved by adding a comparison of the 'unimpaired flows' approach with other science-based approaches to establishing flow requirements for fish and aquatic ecosystems…. The recommended comparisons could evaluate approaches in terms of scientific merit, ability to respond to extreme events and climate change, ability to accommodate other water management objectives (water supply, flood management, etc.), and alignment with regulatory objectives. The comparisons may show how the proposed environmental water-budget approach can combine the best aspects of other scientific approaches for establishing environmental flows. A hybrid approach, which often has value (Kiernan et al. 2012), could allow for more effective and adaptable environmental flows, and these could have less impact on other water users than would a single, less flexible approach." (DSB Review Letter, at 2-3.)

- **Failure To Adequately Consider Non-flow Stressors**: The independent scientists wrote: "The report could do more in assessing the contributions of non-flow stressors to declines in native fish and wildlife in the Delta and estuary…. The report could also provide more information about direct and indirect stress from non-native aquatic plants." (DSB Review Letter, at 5.)

While these comments were directed at the scientific basis report for Phase 2, they are equally applicable in Phase 1. The State Water Board staff proposes the same unimpaired flow approach in these Phase 1 proceedings as the State Water Board staff considered in the scientific basis report for Phase 2. For that reason and as the Public Water Agencies explain herein and as they and others have previously explained, the defects identified by those independent scientists exist here as well. Those important defects, as well as others, are summarized below and explained in detail in the attachment.[4]

[4] The San Luis & Delta-Mendota Water Authority, along with the State Water Contractors, previously submitted detailed comments on the 2012 Substitute Environmental Document and potential Phase 1 amendments. Those comments remain relevant and are incorporated by reference herein. See http://www.waterboards.ca.gov/waterrights/water_issues/programs/hearings/baydelta_pdsed/docs/comments032913/daniel_nelson.pdf.

I. The Proposed Lower San Joaquin River Flow Objectives And Program Of Implementation Lack The Necessary Scientific, Analytical, and Legal Support To Ensure The Reasonable Protection Of Beneficial Uses

A. The "Unimpaired Flow" Approach Fails to Draw a Causal Relationship to Ecosystem Improvement in the Context of the Significantly Altered Bay-Delta Watershed

A fundamental assumption of the flow-centric, unimpaired flow approach is that the dedication of a percent of unimpaired flow will "mimic the natural hydrographic conditions to which native fish species are adapted". (See Draft SED, App. K at 18.) The dedication of a percent of unimpaired flow, however, will not provide "natural" flows in a highly altered ecosystem such as the Bay-Delta watershed.[5] The Bay-Delta watershed has been and continues to be altered substantially – physically, chemically and biologically. As a result, the Bay-Delta watershed has experienced diminished and disrupted habitats such as lost floodplains, the proliferation of non-native invasive species, shifts in the food-webs, and increases in pollutants, among other changes. The Draft SED does not adequately consider the altered ecosystem or the potential effects of the proposed unimpaired flow approach given the alterations. Well-established scientific principles compel such consideration.

The Proposed Flow Objective is premised on the familiar and fundamentally flawed presumption that providing more water necessarily results in more fish. This simplistic framework sets up a false paradigm, in which any decline in the species can be mistakenly attributed to "insufficient" flows, and for which the perpetual response is more water instead of a sophisticated scrutiny of the functions of flow. This approach fails to reflect the existing altered ecosystem and the numerous stressors affecting native fish populations. While the proposed percentage of unimpaired flow approach may be desirable due to its ease of implementation, it lacks the necessary scientific and analytical support to ensure reasonable protection of fish and wildlife beneficial uses.

For example, the analysis assumes that increased flows will result in increased floodplain inundation that in turn provides suitable habitat for fish species. (*See* Draft SED, at 19-52 – 19-74.) It fails to analyze whether the proposed flows will actually provide improved floodplain *habitat* and whether the other variables necessary to provide that function are present. (*Id*., at 19-55.) Functional flows for floodplain habitat require a more robust and tailored approach, which considers the physical habitat characteristics and timing and duration of flows necessary to provide suitable habitat. This ecosystem approach would ensure that flows are being examined in conjunction with the actual habitat needs of fish, and prevent the waste and unreasonable use of flows that only provide more water, not more suitable habitat. To demonstrate this point, a few additional inches in the height of water flowing in a leveed and

[5] *See* Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities, Yarbekk et al., BioScience Advance Access, August 5, 2015; *see also* Department of Water Resources (2010), Comments on the Draft Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives, available at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/comments120610/erick_soderlund.pdf.

rip-rapped channel is not the same as water flowing in a natural river, with riparian habitat, large woody debris, or water flowing over natural riverbanks into the floodplain.

Likewise, the inclusion of "indicators of viability" as standards for the Proposed Flow Objective lacks scientific foundation and implies a causal relationship that that has not been scientifically established. The proposed unimpaired flow approach is unlikely to meet the stated objective of increasing the viability of fish species because it is based on historical correlations that do not provide a scientific basis for specific flow management actions. A basic scientific principle is that correlation does not equal causation. In reviewing the basis for the unimpaired flow approach, the Delta Independent Science Board recently warned against reliance on statistical correlations.

- The independent scientists wrote: "Correlations do not always indicate clear causation." (DSB Review Letter, at 4.)

- The independent scientists wrote: "[R]egressions from past data may not be predictive into the uncertain future, especially in the face of 'regime' changes like the pelagic organism decline and the consequences of climate change." (DSB Review Letter, at 4.)

- The independent scientists wrote: "[S]ome correlations are spurious, and some statistical analyses have led policies astray." (DSB Review Letter, at 4.)

Yet, the Draft SED relies on correlative relationships between past flows and salmon production to present modeled results that are supposed to be "predictive" of the effect of future flows on future salmon production. (*See* Draft SED, Chapter 19.) The Draft SED fails to provide the analytical pathway necessary to move from correlative relationships to developing and evaluating a proposed flow approach that can be linked to the production of native fish populations. The Proposed Flow Objective, which seeks to tie the "efficacy" of flow actions to outcomes such as natural production and viability, is based on the false assumption of a simple flow-fish relationship. This is not scientifically defensible because viability is dependent on numerous factors, including non-flow factors.

B. The Proposed Program of Implementation Fails to Adequately Analyze the Program's Efficacy in Light of Non-Flow Stressors

Further, the proposed program of implementation identifies non-flow measures that *others* could take in the *future* to improve the viability of salmonids. (SED, Appendix K, at 59-64.) That does not satisfy the State Water Board's legal or scientific obligations. In the program of implementation more must be done. The California Legislature found and declared:

> Activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible.

(Water Code, § 13000.) Simply acknowledging there are non-flow stressors on fish populations fails to provide the State Water Board with the necessary information to determine which water quality objectives will ensure the reasonable protection of beneficial uses, considering all the beneficial uses of the water.

Likewise, the California Legislature has directed the State Water Board to consider "[w]ater quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area." (Water Code, § 13241.) Nowhere is there adequate consideration of controlling all factors. As such, these findings and declarations are not respected by the Proposed Flow Objective or in the Draft SED.

The Delta Science Board recently recommended "a deeper analysis of non-flow stressors" in its review of the draft scientific basis report for Phase 2. (DSB Review Letter, at 1.) Yet, the Phase 1 Draft SED and Proposed Flow Objective are proceeding without this "deeper analysis" of the role and relative importance of non-flow stressors of fish populations.

The State Water Board's legal or scientific obligations discussed immediately above have been imposed for good reason. They force a level of consideration necessary to ensure a reasonable protection of beneficial uses of water. Because those obligations have not been satisfied, under the Proposed Flow Objective and program of implementation, water would be taken away from other beneficial uses in the name of certain fish, with no basis for concluding that addressing flow alone will improve the viability of the fish populations. The existing approach presents a significant risk that water will be sent on an impossible mission – in which flow is held solely responsible for addressing a multi-factor condition that flow alone cannot control. Such an approach is not scientifically defensible, and it certainly is not good public policy in a state such as California, where water must be carefully managed to meet the needs of all beneficial uses. Indeed, the redirection of water resources in this matter will likely harm fish, wildlife, and people in urban and agricultural communities.

C. The Analysis Fails to Comply with the California Environmental Quality Act

The legal defects extend to other important components of the Draft SED. The Public Resources Code affords only a limited exemption for certified regulatory programs, and an SED prepared in lieu of an environmental impact report ("EIR") is subject to the substantive provisions of the California Environmental Quality Act ("CEQA"). (Pub. Resources Code §§ 21002, 21080.5; CEQA Guidelines, § 15250.) These include the fundamental duties to identify a project's adverse environmental effects, to mitigate those effects through adoption of feasible alternatives or mitigation measures, and to justify the proposed action based on specific economic, social, or other conditions. (*Sierra Club v. State Board of Forestry* (1994) 7 Cal.4th 1215; *see also* CEQA Guidelines, § 15250.) Under CEQA, a regulatory plan designed to improve environmental conditions must include objective performance criteria by which to measure success. (*POET, LLC v. California Air Resources Board* (2013) 218 Cal.App.4th 681.) The Draft SED does not identify the monitoring or performance standards necessary to assess effectiveness (and therefore the reasonableness and necessity) of the Proposed Flow Objective. The Proposed Flow Objective provides that "[i]ndicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity." (Draft SED, Appendix K at 18.) Thus, to implement a flow objective that

seeks to "support and maintain the natural production of viable" fish populations, the program of implementation must provide the basis for evaluating the relationship between a particular flow action and any particular biological goal. The Draft SED and proposed program of implementation fall far short of this – the "biological goals" that will be used to inform adaptive methods and evaluate the effectiveness of the flow objective are left undefined and deferred to a later, separate process. (Draft SED, Appendix K, at 33.) More importantly, they fail to explain how any cause-and-effect evaluation can be done to assess the effect of flows on specific biological viability indices when such a causal relationship has not been scientifically established.

II. The Update Process And The Current Substitute Environmental Document Have Failed To Provide The State Water Board With Alternatives To The Proposed Unimpaired Flow Approach

The process to develop the Proposed Flow Objective has not provided the State Water Board with a comparative analysis of alternatives to the proposed unimpaired flow approach. The draft technical report for Phase 1, issued back in 2010, only examined various percentages of unimpaired flows.[6] Neither that technical report or any subsequent document produced by State Water Board staff for the Phase 1 proceeding provide the State Water Board with an evaluation of the available alternative methods for setting environmental flows.

This singular focus on an "unimpaired flow" approach is insufficient. Reasonable alternatives exist that were not examined. One such alternatives would be to manage the ecosystem comprehensively, as opposed to a myopic flow-centric approach, by attempting to address the numerous and significant non-flow stressors impacting native fish populations. Another alternative, discussed above, is the "Functional Flow" approach. This approach was recommended by the Delta Stewardship Council in its Delta Plan.[7] The Functional Flow approach is a mechanistic approach for estimating flow needs. This approach has a greater ability to explain anticipated benefits and better integrate management of flow and non-flow stressors. The Delta Independent Science Board has explained that an advantage of this approach "is its greater ability to explain cause-effect and to lead to new knowledge." (DSB Review Letter, at 4.)

Without an examination of flow in the context of other ecosystem factors and an evaluation of alternative approaches to protecting fish and wildlife beneficial uses, the Draft SED does not provide the State Water Board with the information necessary to develop water quality objectives that are tailored to provide the ecosystem functions required to support native fish populations. To adequately perform its duty under Water Code section 13241, the State Water Board must consider a broader range of approaches to setting environmental flows, including the Functional Flow approach. Likewise, to understand the avoidable environmental

[6] See draft technical report at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/techrpt102910.pdf

[7] *See* Delta Plan, Chapter 4, available at http://deltacouncil.ca.gov/sites/default/files/documents/files/CH_04_2013.pdf.

consequences of the Proposed Flow Objective, the Draft SED must be revised to describe and evaluate a Functional Flow approach, as well as other alternative approaches that consider the numerous non-flow stressors impacting fish populations. Analyses of these alternatives, and comparing them against the proposed unimpaired flow approach will allow the State Water Board to better determine the most effective and tailored management approaches, which would provide a reasonable level of protection for all beneficial uses.

III. The Proposed Lower San Joaquin River Flow Objectives And Program Of Implementation Are Contrary To California Law And The Public Interest

The Proposed Flow Objective would reallocate and use significant quantities of water in a manner that is contrary to fundamental principles of California law and the public interest. Requiring that water be used for flow without adequate scientific analysis of what biological functions can realistically be served is contrary to the California Constitutional principles requiring California's water resources to be used reasonably and to the fullest extent of which they are capable. Reallocating water away from other beneficial uses without meaningful consideration of the purported fishery benefits is also contrary to California's water quality laws, including Water Code section 13241, which require consideration of all beneficial uses of water in developing water quality objectives.

The California Constitution declares that the water resources of the State must "be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use . . . of water be prevented . . . ." (Cal. Constitution Art. 10, § 2; see Water Code § 100 [same].) The proposed flow objectives would not put the water resources of the San Joaquin River and its tributaries "to beneficial use to the fullest extent of which they are capable." Flow is a tool for supporting ecosystem functions. However, requiring the dedication of a percent of unimpaired flow, as opposed to dedicating flow where is serves particular functions, is the equivalent of using a hacksaw to conduct surgery: *what is needed is precision*. Article 10, section 2 requires that water be used more as a surgical tool than a blunt instrument. Article 10, section 2 demands that the State Water Board consider more thoroughly the factors that affect the beneficial uses beyond flow, before taking action. Indeed, both environmental and beneficial consumptive uses will suffer from an ineffective and hence inefficient dedication of water supply to increased flow.

The Proposed Flow Objective is also contrary to fundamental requirements of California's water quality laws. A water quality control plan must conform to the State policy that the activities and factors which may affect water quality "shall be regulated to attain the highest water quality which is *reasonable, considering all demands being made and to be made on those waters* and the total values involved, beneficial and detrimental, economic and social, tangible and intangible." (Water Code, § 13000, italics added; § 13240; § 13170.) The State Water Board must "establish such water quality objectives in water quality control plans as in its judgment will ensure the *reasonable* protection of beneficial uses. . . ." (Water Code, § 13241, italics added.) In establishing water quality objectives, the State Water Board must consider: the beneficial uses of the water; the environmental characteristics of the watershed; the water quality conditions that could reasonably be achieved through the control of all factors affecting water quality; and economic considerations. (Water Code, § 13241, subd. (a)-(d).) The proposed flow objective is contrary to these policies. It is not "reasonable" to rely so heavily on

flow in light of the environmental characteristics of this hydrographic region, which are complex and highly-altered. These considerations require a more careful and exacting approach to water quality planning than is advanced in the Proposed Flow Objective.

IV. The Proposed Program Of Implementation For The Southern Delta Salinity Objectives Does Not Reflect Consideration Of All The Factors That Affect Salinity And Unlawfully Assigns Responsibility For Meeting The Objectives

The State Water Board must consider all factors contributing to southern Delta salinity. (Water Code, § 13241, subd. (a), (c), (d).) As the State Water Board has previously recognized, there are multiple factors affecting salinity in the southern Delta, both at Vernalis and downstream of Vernalis.[8] The Draft SED acknowledges that southern Delta salinity is affected by two factors, changes in flow and load, factors that are impacted at multiple locations and by multiple sources. (SED, App. C, at 4-7; *see* SED, at 13-21 – 13-22.) The proposed program of implementation for the Proposed Salinity Objectives does not reflect the necessary consideration of all factors that affect southern Delta salinity. Nor does the proposed program of implementation reflect consideration of changes in the factors that affect southern Delta salinity over the last few decades; in particular the unprecedented reduction in the discharges from Grasslands Bypass Project. (See SED, Appendix K, at 48-49.) The assignment of responsibility for implementing southern Delta salinity objectives must be directly tied to the current factors contributing to salinity concentrations in the southern Delta.

Further, the proposed program of implementation for the Proposed Salinity Objective unlawfully pre-determines water rights conditions that can only be decided in a subsequent water rights proceedings. The proposed program of implementation unlawfully conflates the State Water Board's quasi-legislative water quality planning authority with its quasi-adjudicatory water rights authority and would thus condition fundamental water rights without providing the procedural protections mandated by law. (*U.S. v. SWRCB* (1986) ["*Racanelli*"] 182 Cal.App.3d 82, 101.)) The proposed program of implementation unlawfully assigns responsibility for implementation of the proposed new salinity objectives to specific water right holders. As an example, the program of implementation predetermines responsibility by stating: "DWR and USBR *shall be required* to comply with the 1.0 dS/m water quality objective year-round *as a condition of their water rights*." (Draft SED, Appendix K, at 43, emphasis added.)[9] The State Water Board cannot impose water right conditions as part of a program of implementation in this water quality proceeding. (*Racanelli Decision*, *supra*, 182 Cal.App.3d at p. 101.) Any water right conditions that may be necessary to implement the new salinity objectives must be considered and determined in an adjudicative water right proceeding, which affords water right holders due process.

[8] *See*, *e.g.*, Revised Decision 1641, at pp. 80-89.

[9] For an additional example, see Draft SED Appendix K, at 43 ("DWR's and USBR's water rights shall be conditioned to require completion of the Comprehensive Operations Plan"), at 45 ("DWR's and USBR's water rights shall be conditioned to require continued operations of the agricultural barriers . . .").

CONCLUSION

The Phase 1 amendments and the Draft SED advance an approach to ecosystem management that attempts to recreate a historic flow regime that is impossible in the context of the significantly altered ecosystem of the Bay-Delta watershed. Presumably, the Phase 1 amendments and the Draft SED assume such an approach will resurrect the long-dead characteristics of the natural estuarine system in which native fish species in the Bay-Delta watershed adapted. A significant and growing body of science does not support these assumptions. The "unimpaired flow" approach assumes that all the ecosystem and its species need is more water to improve, without attempt to ensure the water would serve an identified biological function. The Phase 1 amendments and the Draft SED appear to continue to wish away one hundred and fifty years of dredging, channelization, pollution, sequestration, and the introduction of non-native predators for sport in the Delta watershed. Instead, sound science and responsible policy put the following question: *how to responsibly manage for natural functions in what is now the unnatural landscape of the Bay-Delta*.

In this significantly altered system, the large body of scientific information on ecosystem management says flow alone cannot compensate for the physical, biological, and chemical changes that have occurred within the Bay-Delta estuary.

Flow alone cannot create floodplain habitat due to land reclamation and the existing flood protection system.

Flow alone cannot replace lost riparian habitat, cannot replace lost large woody debris.

Flow alone cannot mitigate for the impact caused by rip-rapping the river banks.

Flow alone cannot mitigate for the impact caused by the introduction of non-native, predatory species.

The Public Water Agencies respectfully request that the State Water Board staff revise the Proposed Salinity Objective, Proposed Flow Objective, proposed program of implementation, and Draft SED consistent with these comments, the attachments and the referenced materials. Thank you for your consideration and for your service.

Sincerely,

Jon D. Rubin
General Counsel
San Luis & Delta-Mendota Water Authority

Philip A. Williams
General Counsel
Westlands Water District

Attachments:
1) SLDMWA and WWD Detailed Comments Regarding Phase 1 Amendments and Draft SED
2) Delta Independent Science Board Review Letter (February 23, 2017)

(SLDMWA & WWD March 17, 2017 COMMENT LETTER)

ATTACHMENT

(Detailed Comments on Proposed Amendments to the Bay-Delta Plan and Recirculated SED)

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I. SPECIFIC COMMENTS ON THE PROPOSED SOUTHERN DELTA SALINITY OBJECTIVES, THE PROPOSED LOWER SAN JOAQUIN RIVER FLOW OBJECTIVES AND THE RELATED PROGRAMS OF IMPLEMENTATION

The San Luis & Delta-Mendota Water Authority and Westlands Water District (herein "Public Water Agencies") provide specific comments regarding: (1) the proposed Southern Delta Agricultural Water Quality Objectives ("proposed SDWQ objectives" or "proposed salinity objectives") and related Program of Implementation ("proposed salinity POI" or "proposed POI"); and (2) the proposed Lower San Joaquin River Fish and Wildlife Flow Objectives ("proposed LSJR flow objective" or "proposed flow objective") and related Program of Implementation ("proposed flow POI" or "proposed POI"), as identified in Appendix K of the Recirculated Draft Substitute Environmental Document in Support of Potential Changes to the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality ("SED" or "Recirculated SED").

A. Legal And Evidentiary Defects Of The Proposed Southern Delta Agricultural Salinity Objectives And Related Program Of Implementation

1. The Proposed Salinity Objectives Fail To Adequately Consider The Section 13241 Factors

In establishing water quality objectives that provide "reasonable protection" of beneficial uses, Water Code section 13241 requires the State Water Resources Control Board ("State Water Board") consider the following factors, among others: (1) "[p]ast, present, and probable future beneficial uses of water;" (2) "[w]ater quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;" and (3) "[e]conomic considerations." (Wat. Code, § 13241, subd. (a), (c), (d).) The proposed SDWQ salinity objectives fail to reflect adequate consideration of these factors.

(a) The Proposed Salinity Objectives Do Not Consider The Water Quality Conditions That Could Reasonably Be Achieved Through The Coordinated Control Of All Factors Affecting Water Quality

The proposed salinity POI reveals that the proposed salinity objectives were developed without adequate consideration of the water quality conditions that could reasonably be achieved through the coordinated control of *all factors* affecting water quality. (See Recirculated SED, App. K.) The Recirculated SED states that "[s]alinity levels in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR near Vernalis and evapo-concentration of salt in water that is diverted from and discharged back into southern Delta channels for agricultural purposes [within the southern Delta]." (Recirculated SED, App. C, at p. 4-7; see Recirculated SED, at pp. 13-21 – 13-22.) This statement acknowledges that multiple factors affect salinity concentrations in the southern Delta. Yet, the proposed salinity POI reveals that the 1.0 EC objectives were developed with the assumption that the salinity objectives would be achieved by imposing significant responsibility on the U.S. Bureau of Reclamation ("Reclamation"). As proposed, Reclamation would be obligated to meet a salinity level of 0.7 EC at Vernalis, to provide "assimilative capacity" for downstream diversions and discharges. (See Recirculated SED, App. K., at pp. 42-45.) Similarly, the proposed POI states that "DWR and USBR's water rights shall be conditioned to require . . . the development and implementation of a Comprehensive Operations Plan [that must] describe the actions that will fully address the impacts of SWP and CVP export operations on water levels and flow conditions that may affect salinity conditions in the southern Delta, including the availability of assimilative capacity for local sources of salinity." (*Id.*, at p. 43.)

The Department of Water Resources ("DWR") submitted the results of DSM2 modeling that specifically analyzes the effect of pumping by the CVP and SWP on water quality, water levels, and circulation with and without the temporary barriers. The modeling results demonstrate that CVP and SWP operations usually have no effect on salinity in the southern Delta, and, at times, have a positive effect by lowering salinity concentrations. The models also demonstrate that null zones, which are commonly used as an indicator of poor circulation, occur with the same general frequency and duration with or without CVP and SWP pumping. In addition, spikes in salinity in the southern Delta may not be attributable to poor circulation because salinity sometimes spikes during high flow periods in the absence of null zones. The modeling also demonstrates that CVP and SWP pumping has a small and ephemeral impact on water levels in the southern Delta of approximately 6-8 inches for just a few hours per day. In contrast, the temporary barriers raise water levels well above levels that would occur without CVP and SWP pumping.[1]

Indeed, the Recirculated SED acknowledges this effect of operations of the CVP and SWP. For instance, the SED states that "[h]igher CVP and SWP pumping also results in reduced southern Delta salinity as higher pumping brings more Sacramento River water across the Delta to the export pumps." (Recirculated SED, at p. 2-43.) In addition, the draft SED itself clearly demonstrates that the salt loadings in the Lower San Joaquin River ("LSJR") and southern Delta are not attributable to the CVP or SWP pumping, but rather result from a host of other factors, including agricultural return flows in the southern Delta. (E.g., Recirculated SED, at pp. 13-21 – 13-22.) Yet, by assuming assignment of responsibility to Reclamation and DWR, the proposed amendments ignore the actions that could be taken by other entities that actually contribute to salt concentrations in the southern Delta. The State Water Board should not make the same mistakes it has made in the past, by taking too narrow a focus and failing to consider all of the factors that affect water quality in developing water quality objectives.[2]

(b) <u>The Proposed Salinity Objectives Do Not Adequately Consider The Economic Costs Associated With The Proposed Objectives</u>

The Recirculated SED explains that the "State Water Board based the southern Delta EC objectives on the calculated maximum salinity of applied water which sustains 100% yields of two important salt sensitive crops grown in the southern Delta (beans and alfalfa) in conditions typical of the southern Delta." (Recirculated SED, App. C, at p. 4-2.) However, this approach to establishing the salinity objectives fails to consider and compare the economic costs and benefits of implementing specific salinity objectives. In other words, this approach fails to provide the State Water Board with the information necessary to consider whether it is "reasonable" to establish salinity objectives that provides 100% protection for agricultural beneficial uses of water in light of the economic costs associated with the responsibilities assigned in the proposed POI. For example, the Recirculated SED acknowledges that revising the salinity objectives could involve costs to dischargers complying with a NPDES discharge permit, waste discharge requirements, or complying with a TMDL that is established for protecting agricultural beneficial uses. (Recirculated

[1] Indeed, if the State Water Board is concerned about the impact of water levels on irrigation in the southern Delta, it would be far more cost effective and appropriate to study alternatives such as altering the timing of irrigation pumping in the southern Delta, or changing the location of pumps or siphons that experience issues with fluctuating water levels.

[2] *See U.S. v. SWRCB* (1986) ["*Racanelli* "] 182 Cal.App.3d 82. In *Racanelli*, the court concluded that "the Board made no effort to protect against water quality degradation by [] users [other than Reclamation and DWR] namely, upstream diverters or polluters. As a consequence, the Board erroneously based its water quality objectives upon the unjustified premise that upstream users retained unlimited access to upstream waters, while the projects and Delta parties were entitled only to share the remaining water flows." (*Id.* at p. 118.) The court stated that "the Board cannot ignore other actions which could be taken to achieve Delta water quality, such as remedial actions to curtail excess diversions and pollution by other water users." (*Id*. at p. 120.) The proposed salinity objective and POI reflect the same mistakes found in *Racanelli* – the faulty and narrow presumption that the CVP and SWP will be held responsible for supporting the diversions and discharges of other entities.

SED, at pp. 20-10 – 20-11.) Those are important considerations. However, the SED fails to account for other costs, such as the costs associated with mandating the installation and operation of the temporary barriers and conducting the studies and monitoring identified in the proposed POI. These costs are necessary considerations.

2. The Proposed Program Of Implementation Illegally Conflates The State Water Board's Legislative Water Planning Function And Its Adjudicative Water Right Function

The State Water Board performs dual functions—its legislative function of developing and amending water quality control plans and its adjudicatory function of allocating water rights. Consideration and determination of what, if any, water right conditions are necessary to implement *new* water quality objectives must be performed in an adjudicative proceeding. (*See Racanelli*, *supra*, 182 Cal.App.3d at p.113 ["in undertaking to allocate water rights, the Board performs an adjudicatory function."].) The Recirculated SED acknowledges this rule and repeatedly asserts that the State Water Board will consider any necessary changes to water rights to implement the amendments to the water quality control plan in a later water right proceeding.[3] Unfortunately, the proposed amendments and POI pre-determine many water right conditions. For example, the proposed POI pre-determines that DWR and Reclamation's water rights *will be* conditioned to: 1) develop and implement a Comprehensive Operations Plan to address how SWP and CVP operations "might affect the assimilative capacity for local sources of salinity in the southern Delta;" 2) develop and implement a special monitoring study to characterize water level, flow and salinity conditions in the southern Delta; 3) to require continued operations of the agricultural barriers program; and 4) develop a monitoring and reporting protocol to provide the data necessary to assess attainment of the salinity objectives. (Recirculated SED, App. K.) Such an approach illegally conflates the State Water Board's legislative water quality planning function with its adjudicative water rights function and fails to provide the targeted water right holders with the procedural protections and due process provided by an *adjudicative* water right proceeding.

(a) The State Water Board Cannot Decide In The Program Of Implementation To "Continue" To Condition The Water Rights Of Reclamation And DWR To Implement Water Quality Objectives During This Quasi-Legislative Water Quality Planning Process

The "guiding principle" in any water right proceeding commenced to implement a water quality control plan is that the State Water Board's power to act in such a water rights proceeding "is constrained by the terms of the plan it is implementing." (*State Water Resources Control Bd. Cases* (2006) 136 Cal.App.4th 674, 729 at p. 729.) The proposed SDWQ salinity objectives would amend the existing southern Delta salinity objectives in the Bay-Delta Plan (0.7 EC April-August and 1.0 September-March) to require 1.0 EC year-round. (Recirculated SED, App. K, at p. 15; Bay-Delta Plan at p. 13.) Therefore, the inquiry in any water right proceeding commenced to implement the new salinity objectives would be: "what water right conditions, if any, are necessary to implement the 1.0 dS/m salinity objective." Thus, because the State Water Board would be seeking to implement a new salinity objective, it must perform a new evaluation and determination

[3] See, e.g., Recirculated SED, at p. 1-2 ["the State Water Board will evaluate, in a subsequent water rights proceeding, whether to impose responsibility on surface water users who divert surface water from the Stanislaus, Tuolumne, and Merced River Watersheds above the major dams."]; *Id.,* at p. 1-3 ["In Phase III, the State Water Board will conduct proceedings to assign responsibility for actions to implement the water quality objectives established in Phase I and Phase II, including changes to water rights or other implementation actions."]; *Id.* at p. 1-8 [the "State Water Board's Phase III would specifically identify the water rights that could be modified as a result of adopting and applying the program of implementation for the LSJR flow objectives analyzed in this SED as part of Phase 1."]; *Id*., App. C, at p. 1-1 ["Any changes to water rights consistent with the revised program of implementation will be considered in a subsequent adjudicative proceeding."].

of the water right conditions, if any, necessary to implement those salinity objectives, in a water right proceeding.

Although the proposed salinity objectives would effectively eliminate the 0.7 EC salinity objectives that currently exist in the Bay-Delta Plan, the proposed POI assumes that Reclamation will be required to operate to achieve the objectives. The proposed POI states:

> For the San Joaquin River at Airport Way near Vernalis, Revised Water Right Decision 1641 imposes conditions on USBR's water rights requiring implementation of EC levels of 0.7 mmhos/cm from April through August and 1.0 mmhos/cm from September through March (units of mmhos/cm are equal to units of dS/m). As part of implementing the salinity water quality objective for the interior southern Delta, *USBR shall be required to continue to comply with these salinity levels, as a condition of its water rights*.

(Recirculated SED, App. K, at p. 42, italics added.)[4] Also, the proposed POI states:

> Revised Water Right Decision 1641 imposes conditions on DWR's and USBR's water rights requiring implementation of EC levels of 0.7 mmhos/cm from April through August and 1.0 mmhos/cm from September through March at the three compliance stations in the interior southern Delta (Interagency Stations No. C-6, C-8, and P-12). As part of implementing the salinity water quality objective for the interior southern Delta, DWR and USBR shall be required to comply with the 1.0 dS/m water quality objective year-round as a condition of their water rights.

(Recirculated SED, App. K, at pp. 42-43.) In addition, the POI states:

> *DWR and USBR's water rights shall be conditioned to require* continued operations of the agricultural barriers at Grant Line Canal, Middle River, and Old River at Tracy, or other reasonable measures, to address the impacts of SWP and CVP export operations on water levels and flow conditions that might affect southern Delta salinity conditions, including the assimilative capacity for local sources of salinity in the southern Delta.

(Recirculated SED, App. K, at p. 45, italics added.) However, the State Water Board cannot pre-determine the water right conditions necessary to implement the salinity objectives, and the proposed POI's assumption that the State Water Board will continue to require the water right conditions imposed to implement the Bay-Delta Plan is contrary to law.

[4] See, e.g., Recirculated SED at p. 11-6, Table 11-1 [water quality within the southern Delta under SDWQ Alternatives 2 and 3 "is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis."]; at p. 11-43 [the "program of implementation for the numeric salinity objectives contained in SDWQ Alternatives 2 and 3 includes continued USBR compliance with the Vernalis salinity requirement currently established in the 2006 Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary (2006 Bay-Delta Plan) and implemented through the State Water Board's Water Right Decision 1641 (D-1641)."]; at p. ES-50 ["Revised D-1641 imposes conditions on USBR's water rights requiring implementation of EC levels of 0.7 mmhos/cm from April–August and 1.0 mmhos/cm from September–March at Vernalis (units of mmhos/cm are equal to units of dS/m). USBR would continue to be required to comply with these salinity levels, as a condition of their water rights, in order to implement and meet the proposed salinity water quality objective in the interior southern Delta."].

(b) An Adjudicative Water Right Proceeding Is Necessary To Provide Due Process To Water Right Holders

A right to appropriate water is recognized as a private property right and "once rights to use water are acquired, they become vested property rights." (*Racanelli Decision*, *supra*, 182 Cal.App.3d at p. 101.) The Constitution prohibits a state from depriving any person of property "without due process of law." (Sec. 1, Amendment XIV, U.S. Constitution.) Thus, appropriative water rights "cannot be infringed by others or taken by governmental action without due process and just compensation." (*Racanelli Decision*, *supra*, 182 Cal.App.3d at p. 101.) Therefore, the procedural protections provided by law with respect to appropriative water rights are necessary to ensure that due process is provided by the State. The proposed POI for the salinity objectives deprives Reclamation and DWR, their respective contractors, including members of the Public Water Agencies, and likely others of due process by attempting to impose water right conditions through this legislative water quality planning process.

An adjudicative water right proceeding provides additional procedural protections to water right holders that are not provided in the legislative water quality planning process. For example, in an adjudicative water right proceeding, each party has the right to call and examine witnesses, to cross-examine opposing witnesses, and to rebut evidence against him or her. (Gov. Code, § 11513, subd. (b); Gov. Code, § 11425.10, subd. (a); 23 C.C.R. § 648, subd. (b) [listing applicable procedures in State Water Board adjudicative proceedings].) In addition, the decision issued in a water right proceeding must include "a statement of the factual and legal basis of the decision . . .." (Gov. Code, § 11425.10, subd. (a); 23 C.C.R. § 648, subd. (b).) These procedural rights, and others provided for in adjudicative proceedings, ensure that parties to such proceedings receive due process and an opportunity to contest the State Water Board's evidence. If adopted, the proposed POI for the SDWQ salinity objectives would deprive Reclamation and DWR, their respective contractors, including members of the Public Water Agencies, and likely others of these procedural rights by pre-determining the conditions that will be placed on water rights, prior to providing the due process afforded in an adjudicative water right proceeding.

In addition, the State Water Board is held to a higher evidentiary standard in making water rights decisions than it is in developing water quality control plans. In reviewing the State Water Board's legislative actions, such as amendments to a water quality control plan, the courts apply a deferential standard of review and a court will "'uphold the agency action unless the action is arbitrary, capricious or lacking in evidentiary support.' [Citation.]" (*Racanelli Decision*, *supra*, 182 Cal.App.3d at p. 113.) In contrast, in reviewing the validity of water right permit conditions imposed through an adjudicative proceeding, the courts must determine whether "the conditions are supported by 'precise and specific reasons founded on tangible record evidence.' [Citation.]" (*Id*. at p. 115.) Also, an administrative agency is required to make findings that bridge the analytic gap between the raw evidence and the ultimate decision when it issues an adjudicative decision, but not when it issues a legislative decision. (*Id*. at p. 114.) Thus, the nature of the proceeding determines the evidentiary standard the State Water Board must meet and adjudicatory actions provide more protection for the parties and rights affected by the agency action, by providing a more demanding evidentiary standard.

3. Assignment Of Responsibility For Implementing The Salinity Objectives Should Be Commensurate With A Party's Contribution To Salinity

The Recirculated SED states that the "[e]levated salinity in the southern Delta is caused by *various factors*, including low flows; salts imported to the SJR Basin in irrigation and wetland supply water; municipal discharges; subsurface accretions from groundwater; tidal actions; diversions of water by the CVP, SWP, and local water users; channel capacity; and agricultural drainage discharges to the SJR upstream of the Delta and in the Delta."." (Recirculated SED, at p. 1-9,

italics added.) However, rather than address these various factors affecting salinity in the southern Delta, the proposed POI would require Reclamation to provide "assimilative capacity" downstream of Vernalis for salinity inputs by others. (See Recirculated SED, at pp. 1-11 – 1-12 [under SDWQ Alternatives 2 and 3 "USBR's water rights would continue to be conditioned to meet EC levels of 0.7 dS/m August and 1.0 dS/m from September–March in the SJR at Airport Way Bridge near Vernalis to provide assimilative capacity for salinity inputs downstream of Vernalis."].) The SED does not explain why it is appropriate to burden Reclamation's water rights to accommodate salinity contributions by other parties. Nor does it explain why it is appropriate to require Reclamation and DWR to install, operate and maintain barriers, conduct the specified monitoring, and conduct the specified studies. (See Recirculated SED, App. K, at pp. 41-46; see also SED, at p. 16-215) There is also no valid basis for imposing permit conditions on the CVP and SWP, including those that require the Reclamation and DWR, and likely the Public Water Agencies, to fund monitoring and studies, install temporary barriers. (Id.) It is beyond reasonable dispute that multiple factors affect the concentration of salinity in the waters of the San Joaquin River and southern Delta. Indeed, the draft SED acknowledges that salinity conditions in the southern Delta are affected by various factors. (Recirculated SED, at p. 1-9.) Thus, it is unreasonable and unlawful to require Reclamation to provide assimilative capacity or to require Reclamation and DWR to install, operate and maintain barriers, conduct the specified monitoring, and conduct the specified studies.

4. <u>The Assignment Of Responsibility For Implementing The Salinity Objective Must Reflect The Substantial Reduction In Salt Discharge Upstream Of Vernalis</u>

While the SED briefly describes several of the projects that have significantly reduced salinity loading in the San Joaquin River from lands irrigated with CVP water, the proposed POI's assignment of responsibility to Reclamation for implementing the proposed new salinity objectives does not reflect consideration of these reductions. (See Recirculated SED, App. K, at pp. 42-52.) The contribution of salinity to the San Joaquin River from lands irrigated with CVP water have changed considerably since the State Water Board last closely examined San Joaquin salinity standards in the 1995 Water Quality Control Plan amendments and in D-1641. At the time the State Water Board adopted D-1641, there was a concern that the Vernalis salinity objective would not be met. Indeed, Reclamation "acknowledged that on occasion salinity objectives at Vernalis will not be met under its plan." (D-1641, at p. 80.) The State Water Board found that "the actions of the CVP are the principal cause of the salinity concentrations exceeding the objectives *at Vernalis*." (*Id.* at p. 83, italics added.) The effect of CVP-related irrigation and other activities is very different today, something the Recirculated SED does not sufficiently acknowledge or consider.

There have been no exceedances of the salinity objective at Vernalis since D-1641 was adopted. The Grasslands Bypass Project ("GBP") has achieved substantial reductions in salt discharges to the San Joaquin River. (See Recirculated SED, App. K, at p. 48 [monitoring data from 1995-2015 shows that Grasslands Bypass Project reduced the discharge of salts by 83% compared to pre-GBP conditions].) The GBP is regulated through waste discharge requirements issued by the Central Valley Regional Water Quality Control Board ("Central Valley Regional Board"), an important fact not mentioned in the description of the project. (*Id*.) The GBP gathers subsurface drain water from some 90,000 acres of farmland located west of Firebaugh, California, lands that are irrigated with CVP water. The regulations and agreements governing the GBP require further dramatic drainage reductions that will continue to reduce discharges of salinity, while drainage management through the project will allow viable agriculture to be maintained.

In addition, other programs on the west side of the San Joaquin Valley are addressing salinity on lands not within the GBP. The Irrigated Lands Regulatory Program ("ILRP") includes

measures addressing drainage discharges from irrigated agricultural lands that reach the San Joaquin River. (See Recirculated SED, App. K, at p. 47.) The ILRP initially requires monitoring and data collection that will guide later management. In addition to program requirements for monitoring the discharge of salts, priority management practices, such as installation of drip irrigation and tailwater recirculation systems to avoid sediment discharges, are expected to have incidental but immediate benefits in reducing discharges of salts. The ILRP, along with the waste discharge requirements for the GBP, will be used to implement the TMDL for salinity in the lower San Joaquin River. (*Id*.) Reclamation has entered into and is updating a Management Agency Agreement with the Central Valley Regional Board that is engaging stakeholders, including state and federal refuges, among others, in the development of a real time program for managing discharges to address salinity concerns. (*Id*.)

In sum, much has changed since adoption of the 1995 WQCP and D-1641 regarding the CVP's contribution to salinity in the San Joaquin River upstream of Vernalis. There have been no exceedances of the standard at Vernalis since D-1641 was adopted. The GBP has achieved substantial reductions in salt discharges from agricultural lands irrigated with CVP water. These reductions in salinity discharges upstream of Vernalis, should be reflected in the proposed POI for any new southern Delta salinity objectives and considered in determining responsibility for implementing those objectives. Consideration of these reductions and changes in salinity contributions is essential to developing sound amendments to the existing water quality control plan, including to the program of implementation.

B. Legal And Evidentiary Defects Of The Proposed Lower San Joaquin River Flow Objective & Related Program Of Implementation

1. Flow Is Not A Proper Parameter For A Water Quality Objective Under Porter-Cologne

The proposed LSJR flow objective is unlawful because flow is a not a proper parameter for a water quality objective. "Water quality objectives" are defined in the Porter-Cologne Act as the "limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." (Wat. Code, § 13050, subd. (h).) Temperature, pH, dissolved solids, pathogens, dissolved oxygen, and chemical constituents such as pesticides are all examples of "water quality constituents or characteristics." Flow, by contrast is the physical *movement* of water in a watercourse. While flow may affect water quality, flow is not a water *quality* constituent or characteristic of the water. Flow is therefore outside the scope of a water quality objective as defined in section 13050, subd. (h). The State Water Board's current task is to consider potential amendments to water quality objectives. Questions of flow may be properly addressed as part of implementation, in a water rights proceeding.

The Porter-Cologne Act defines "quality of the water" separately and differently from its definition of "water quality objectives." "Quality of the water" is defined as the "chemical, *physical*, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use." (Wat. Code, § 13050, subd. (g), emphasis added.) Flow, and volume too, are physical properties of a water body. By contrast, the definition of "water quality objective" does not include the term "physical."

Notably, the defined term "quality of the water" is not used in the provisions of the Water Code that govern water quality control plans. Instead, it appears in a provision of the Water Code that prohibits the commingling of transferred water resulting in a diminution of the quality of the water (Wat. Code, § 1810), and in a provision that defines a "project" in the context of groundwater basin protection (Wat. Code, § 12921.3). The term also appears in provisions pertaining to specific

projects and entities. For example, section 5901 addresses the deterioration of the quality of the waters of the Upper Klamath River Basin, sections 13951 and 13952 address waste disposal affecting the quality of waters in Lake Tahoe, and sections 50903 and 60230 enable small reclamation districts and water replenishment districts, respectively, to take certain actions to protect the quality of local waters. The Legislature's choice to use a term that includes physical properties in some contexts, but not in the water quality control plan provisions, is a strong indicator that it did not intend for plans to define objectives using physical properties of a water body such as flow.

There are sound policy and practical reasons for excluding properties such as flow and volume from water quality control plans. As discussed above, water quality control plans and water rights proceedings are subject to differing standards and requirements. The distinction between the two is breached when water quality objectives are expressed in terms of flow, because that can predetermine what water rights may be affected and by how much, without the benefit of due process.

The term "quality of the water" appears in only one reported California case. (*State Water Resources Control Board Cases*, *supra*, 136 Cal.App.4th at p. 699.). In that case, the court said that "[w]ater flow can be regulated as a water quality objective because, as the Board explained in the 1995 Bay-Delta Plan, 'the rate and quantity of flow . . . are physical properties or characteristics of the water' which 'have an impact on the beneficial uses of' water in the Bay-Delta." (*Id*. at p. 701 [citing Wat. Code, § 13050, subd. (g)].) This was *dictum*, however, because no party in that case challenged the State Water Board's authority to set flow-based objectives, which were adopted following the Delta Accord. Further, the court did not explain how the definition of "quality of the water" it quoted could be substituted for the pertinent and materially different definition of "water quality objective" provided in Water Code section 13050(h).

The 1995 Bay-Delta Plan illustrates that for many years the State Water Board has taken the position that it may set flow objectives in a water quality control plan, despite the definition of "water quality objective" in section 13050(h). Assuming *arguendo* that the State Water Board's interpretation is not contrary to section 13050(h), it is still unlawful for failure to comply with the California Administrative Procedure Act, California Government Code §§ 11340 *et seq.* ("APA"). A "regulation" within the meaning of the APA includes "every rule, regulation, order, or standard of general application or the amendment, supplement, or revision of any rule, regulation, order, or standard adopted by any state agency to implement, interpret, or make specific the law enforced or administered by it, or to govern its procedure" (Gov. Code, § 11342.600). Under the APA, a promulgating agency "must comply with the procedures for formalizing such regulation, which include public notice and approval by the Office of Administrative Law. . ." (*County of Butte v. Cal. Emergency Medical Services Authority, Inc.* (2010) 187 Cal.App.4th 1175, 1200 [internal quotations and citations omitted].) In *Tidewater Marine Western, Inc. v. Bradshaw* (1996) 14 Cal.4th 557, 571, the California Supreme Court explained that a regulation is subject to the APA if it has two principal identifying characteristics: (1) "the agency must intend its rule to apply generally, rather than in a specific case;" and (2) "the rule must 'implement, interpret, or make specific the law enforced or administered by [the agency], or . . . govern [the agency's] procedure.'" (Citing Gov. Code, § 11342, subd. (g).) The State Water Board's claim of authority to include flow as a water quality objective meets these criteria. Yet, the State Water Board has never formally adopted a regulation setting forth its expanded definition of water quality objectives. Accordingly, a water quality objective defined by flow would be based on an underground regulation, and hence invalid. (*Niles Freeman Equipment v. Joseph* (2008) 161 Cal.App.4th 765 [citing *Kings Rehabilitation Center, Inc. v. Premo* (1999) 69 Cal.App.4th 215, 217.].)

2. The Proposed Program Of Implementation Fails To Consider And Balance Competing Beneficial Uses Of Water

In developing water quality objectives, the State Water Board is directed to consider *all* competing demands for water in determining what is a reasonable level of water quality protection . (Wat. Code, § 13000.) In the *State Water Resources Control Bd. Cases*, the court described the Board's duty to consider and balance competing beneficial uses of water as follows:

> In formulating the 1995 Bay–Delta Plan, the Board set out "to attain the highest water quality which is reasonable, considering *all* demands being made on the water of the [Bay–Delta]." (1995 Bay–Delta Plan, p. 14, italics added.) While the Board had a duty to adopt objectives to protect fish and wildlife uses and a program of implementation for achieving those objectives, in doing so *the Board also had a duty to consider and protect all of the other beneficial uses to be made of water in the Bay–Delta, including municipal, industrial, and agricultural uses.* It was for the Board in its discretion and judgment to balance all of these competing interests in adopting water quality objectives and formulating a program of implementation to achieve those objectives.

(*State Water Resources Control Bd. Cases*, *supra*, 136 Cal.App.4th at p. 778, second italics added.) Thus, the State Water Board has a duty to both protect fish and wildlife beneficial uses and other beneficial uses of water in developing flow objectives. Unfortunately, the SED fails to meaningfully evaluate the State Water Board's duty to balance competing beneficial uses in developing the flow objective. The SED states that one of the goals related to the flow objectives is:

> In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.

(Recirculated SED, at p. 3-2.) While the SED includes this statement, the SED does not provide an analysis or explanation of what is considered "reasonable" protection of fish and wildlife in consideration of all of the demands for the water at issue. The proposed flow objective and POI does not effectuate the State Water Board's duty to balance the competing beneficial uses of water because it provides for an "unimpaired" flow regime that would require significant reductions in water diversions for other beneficial uses, in the face of significant uncertainty regarding the benefits of the proposed flow objectives on fish populations.

It is unclear how the State Water Board can fulfill its statutory duty to consider and balance competing demands for water in developing water quality objectives if the SED fails to evaluate those competing beneficial uses of water. The SED asserts: "[t]he flow proposal would provide the flow conditions necessary to reasonably protect fish and wildlife beneficial uses. The proposed flows are higher than the existing flow requirement. Implementation of these higher flows would reduce water available to water users in the LSJR Watershed more often than does the current objective." (Recirculated SED, at p. ES-4.) Yet, the SED does not provide an analysis of what is considered "reasonable" protection of fish and wildlife beneficial uses in light of the other users of this water, such as for agricultural and municipal and industrial uses. In other words, the SED does not grapple with the trade-offs inherent in taking water from other beneficial uses and dedicating it to fish and wildlife. But the SED does reveal that the proposed flow objective of 30%-

50% of unimpaired flow would have significant impacts on other beneficial uses of water. For example, the SED shows that the proposed flow objective (LSJR Alternative 3) will have significant and unavoidable impacts on agricultural supply and recreation. (See Recirculated SED, at p. ES-52; see also Wat. Code, § 13050, subd. (f) [identifying agricultural supply and recreation as beneficial uses of water]; see also Revised Draft SED 2016, Section 3.3.6) While the SED attempts to quantify the expected fishery benefits of these proposed additional flows, the analysis is based on flawed modeling and correlative relationships that fail to account for the complexity of the ecosystem under today's physical and biological conditions. (See Recirculated SED, Chapter 19 and App. C.) Given the uncertainties and complexity of flow-fish relationships, any assumed fishery benefits from the proposed flow objective are at best highly speculative.

In light of the impacts to other beneficial uses of water, it is unclear how the proposed flow objective's "unimpaired flow" regime satisfies the State Water Board's duty to consider and balance the competing beneficial uses of water in developing water quality objectives. The SED states that "[f]low needed for the protection of fish and wildlife beneficial uses will be balanced against flow needs for other beneficial uses of water including: agriculture and hydropower production." (Recirculated SED, App. C, at p. 3-59.) The proposed flow objective and POI does not reflect a balanced approach to the protection of all beneficial uses of water in the plan area.

3. The Proposed Flow Objective And Program Of Implementation Lack A Strong Technical Basis

(a) Applying The Unimpaired Flow Metric Does Not "Mimic The Natural Hydrographic Conditions To Which Native Fish Species Are Adapted"

The SED asserts that:

> [S]cientific evidence indicates that in order to protect fish and wildlife beneficial uses in the SJR basin, including increasing the populations of SJR basin fall-run Chinook salmon and Central Valley steelhead to sustainable levels, changes to the current flow regime of the SJR basin are needed. Specifically, a more natural flow regime from the salmon bearing tributaries (Stanislaus, Tuolumne, and Merced Rivers) is needed during the February through June time frame.

(Recirculated SED, App. C, at p. 3-2.) However, the SED overlooks that "unimpaired flow" is not, and cannot be, the same as a "natural" flow regime in a highly modified ecosystem such as the Bay-Delta. The SED also states that "[u]sing a river's unaltered hydrographic conditions as a foundation for determining ecosystem flow requirements is well supported by scientific literature [Citations]." (*Id*. at p. 3-40.) This statement fails to acknowledge that "unimpaired flow" is not the same as "unaltered hydrographic conditions" because the physical structure of the streams, rivers, and the Bay-Delta estuary has been so altered that unimpaired flow conditions will not reflect or mimic the "natural" hydrographic conditions that existed in the predevelopment era. The "unimpaired flow" regime is a simplistic short-hand approach that attempts to provide more variability in flow, but such a flow regime will not approximate "natural flow," nor will it restore the complex habitat that native fish species are adapted to or many of the functions that predevelopment flows may have provided.

First, the proposed flow objective would modify the hydrograph in the lower reaches of these tributaries, the San Joaquin River and Delta, all of which are highly altered. The SED should explain that even to the extent the percent of the unimpaired hydrograph approach may approximate natural hydrology in the upper tributaries, the unimpaired flow approach would not result in a "natural" hydrographic conditions in the lower reaches of these tributaries, the San Joaquin River and Delta.

Second, the proposed "unimpaired flow" aspect of the flow objective only includes a portion of the year (February-June), even though the existing standard includes flows in October. The SED does not provide an adequate explanation for why excluding nearly half of the year's hydrograph still represents "natural" conditions. Juvenile steelhead rear within in the San Joaquin River tributaries year-round and require suitable instream flows and cold water temperatures, particularly in the late spring, summer, and fall to support their growth and survival. Similarly, adult fall-run Chinook salmon adults migrate into the San Joaquin River, and its tributaries, in the fall (September-December) where they spawn and eggs incubate. Providing instream flows and maintaining suitable cold water for salmon spawning and egg incubation is necessary to their reproductive success and subsequent abundance (year class strength). Limiting changes in flow to less than half the year does not allow a holistic managing approach in which all life stages' needs are analyzed and provided for.

Third, the proposed POI describes a process where the Executive Director could decide in any year to deviate from the pattern of the unimpaired flow hydrograph based on an exercise of his or her discretion indicating that a different flow would benefit the fishery. (See Recirculated SED, App. K, at pp. 28-32.) The proposed POI would allow the water to be managed as a block of water, rather than under the pattern of unimpaired flow, and would allow shifting of water outside of the February-June period. (Id.) These allowed deviations from the unimpaired flow approach are inconsistent with the stated basis for the increased flows – which is to "mimic" the natural hydrographic conditions. The SED provides no discussion of the types of habitat and biological monitoring data, rationale, or analyses that would be used as the technical basis for modifying the instream flow schedule within a year. The reservation of authority for the Executive Director further deviates from a "natural" pattern. The lack of description of 1) decision support models, 2) quantitative predictions or performance standards, and 3) monitoring specifications, are all indicators that this is a watered down version of adaptive management, "Adaptive Management Lite" (AM-Lite), and this approach often fails (Ruhl and Fischman 2010).

Fourth, while the calculated percent of the unimpaired hydrograph approach may approximate natural flow patterns in the tributaries below the dams, it does not do so downstream on the San Joaquin River and in the south Delta. Once flow enters the valley, it cannot be considered "natural" as the current channel configuration and physical environment are drastically transformed from historic conditions. Levees, channelization, and land use changes have dramatically altered the relationship between instream flows and seasonal floodplain and wetlands inundation on the lower San Joaquin River and Delta from historic conditions. The functional relationships and biological benefits to juvenile salmonid rearing on intermittently inundated habitat in the basin may have changed in a fundamental manner and merely mimicking historical flows will not necessarily lead to viable populations; thus the basic premise of the unimpaired flow strategy is flawed. Today's highly altered conditions are relevant because the seasonal timing and magnitudes of flow under historic conditions were highly modified through interactions with channels, wetlands and floodplains, groundwater recharge, consumptive use by native vegetation, and evaporation. These interactions moderated the timing and magnitude of outflow, and dictated localized hydrodynamic patterns. These interactions also affected the functions that these flows provided; functions that are not necessarily replicated by equivalent flows through today's channels.

The SFEI Report, Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process, contains a detailed description of the historic south Delta. The report describes the physical environment as well as the likely historic hydrograph, as follows:

> The South Delta is defined by the distributaries and meanders of the San Joaquin River upstream of the central Delta. At the landscape scale, the south Delta historically presented an array of tidal wetlands interwoven with distributary riverine channels and non-tidal floodplains across a broad transitional zone, or ecotone. Early travelers encountered rivers that were formable only late in the season, often with dense willow and oak riparian forest along their banks. Beyond forested natural levees, the land surface sloped away to meet a matrix of perennial wetlands (dominated by tule, Schoenoplectus spp.), patches of sedges and grasses, perennial and intermittent ponds, and overflow channels. This floodplain was challenging to traverse for much of the year, owing to annual inundation.

(SFEI, South Delta, at p. 309.) The SFEI report further describes 12,000 acres that once were comprised of an extensive mosaic of wetlands and adjacent upland habitat types of the south Delta, generally defined as extending from Roberts and Union Islands to the Stanislaus River. (*Ibid*.)

The historic hydrograph on the San Joaquin River was also different than on the Sacramento River, as follows:

> The south Delta marked the terminus of the San Joaquin River, a large riverine system that frequently overflowed its banks to fill numerous secondary channels, ponds, and floodplain wetlands. It conveyed floodwaters that spread and inundated land sometimes several feet in depth before much of it entered downstream tidal channels in the central Delta. In contrast to the more rainfall-event driven hydrograph of the Sacramento River, winter floods were less frequent on the San Joaquin, with flooding typically snowmelt-driven. The resulting hydrograph was characterized by fewer peak flood events and exhibited a gradual rise of river stage in the late spring and early summer. Also different from the northern flood basins, the south Delta floodplains were apparently less isolated from the river by natural levees (presumably related, in part, to the lower flood peaks and sediment supply in comparison to the Sacramento River). This greater hydrologic connectivity was maintained through multiple side channel systems that made floodplain hydrology more responsive to river stages and enabled water to pass through the system with relative speed. Masses of woody debris obstructed the main channels at certain locations, such as Old River near the present day Fabian Tract, affecting flows and habitat complexity. The combination of these factors meant that floodwaters were found in a wetland complex, likely associated with the many secondary side channels and oxbow lakes. The comparison to the lower Sacramento River riparian forests, a greater proportion seems to have been composed of willows and other shrubs, as opposed to oaks and sycamores.

(SFEI, South Delta, at pp. 312-313.)

As a result of the changes that have occurred from historic conditions to present, making releases based on the calculated hydrograph will not result in the timing or magnitude of flows described above nor will it “mimic” the historic functions that instream flows supported for juvenile salmonid rearing and other biological processes. In fact, the south Delta has changed so substantially that the historic wetland complex found there that provided habitats that supported migratory fish survival and growth no longer functions in the same way. For one and a half centuries, wetland conversion and levee construction has taken place in the Delta (Thompson 1957). Land “reclamation” changed the complex distributary pattern of the Delta (Mount 1995) and the intricate anabranching (Nanson and Knighten 1986) channels gave way to much more

simplified anabranching channels protected by levees. Irrigated agriculture became the dominant land use and with that came a transformation in stream water chemistry, e.g. nitrogenous and phosphoric nutrients increased. Also, some urbanization took place and runoff from these areas contributes pollutants such as polycyclic aromatic hydrocarbons (Pareira et al. 1996). Dubrovsky et al. (1998) found that organophasphate insecticides in runoff frequently exceed established concentration criteria for the protection of aquatic life. This changed physical and chemical environment was further altered by the introduction of dozens of exotic species including numerous species of fish predators, e.g. striped bass and numerous centrarchids. One of the results of all these changes to the physical, chemical, and biotic environment was that the Delta changed so extensively that even in a high flow year like 2011 survival through the Delta was only 2% for Chinook salmon from Durham Ferry to Chipps Island (SJRGA 2011: Table 5-21).

Similar to instream flow, the outflow from the San Joaquin River to the ocean will not approximate "natural" or historic conditions. This means that the through-Delta flows targeting improved juvenile salmon passage cannot be defined as "natural." The proposed amendments and Recirculated SED do not adequately reflect these facts.

Finally, the SED fails to explain how an unimpaired flow approach can "mimic" historic conditions in the face of climate change. The most likely consequences for salmonids on the west coast of North America from climate change are more precipitation as rain rather than snow, altered timing of the flow regime, increased maximum flows in rivers, and increases in water temperatures (ISAB 2007). Thus, under climate change, the flow regime is going to be shifting and will not resemble the historic flow regime. Yet, the SED does not critically examine the effects of climate change or consider those changes as part of the proposed flow objective or program of implementation.

(b) <u>There Is A Lack Of Evidentiary And Analytical Support For The Program Of Implementation's Proposed Flow Regime</u>

While flows are important for ecological functions and physical processes that support native fish populations, it does not follow that an "unimpaired flow" regime in a highly altered watershed and estuary will provide the conditions needed to support those biological and ecosystem processes. The Recirculated SED does not contain an analysis establishing that the salmonid population viability metrics (e.g., abundance, spatial extent or distribution, genetic and life history diversity, and productivity) can be achieved by providing flows that mimic the natural hydrograph. Even if this analytical connection had been made, it has not been sufficiently established that the implementation of the proposed POI would provide "natural" flows under which the fish evolved and were adapted (e.g., the relative magnitude, duration, timing, and spatial extent of historic flows). As discussed in detail below, the SED fails to provide analytical or evidentiary support for the presumption that the proposed flow regime will support native fish populations.

In Appendix K, the State Water Board explains that biological goals will be developed to measure the viability of salmonids. (App. K, at p. 33). Their goals mimic the same Viability of Salmon Population (VSP) parameters that are utilized by the Recovery Plan for Central Valley salmonids (NMFS 2014). Similar to the Recovery Plan, the State Water Board specifies that the biological goals that will inform the adaptive methods will address the 4 parameters of abundance, productivity, spatial structure, and diversity. However, the State Water Board provides no analyses linking how the proposed adaptive strategy of shifting % unimpaired flow targets will achieve each of the four VSP criteria. The SED and program of implementation fail to describe the hypotheses that could support linking proposed flow changes with each of these four criteria. Critically, the SED fails to disclose or address that there are many ecosystem variables other than flow that affect the viability of salmonids. It is unclear how the State Water Board will be able to evaluate

the effect of the unimpaired flow approach in the face of so many confounding variables. The State Water Board does not have a scientific basis for attributing a cause and effect relationship between flow actions and changes in the viability parameters.

The State Water Board provides no analyses linking their proposed adaptive methods and the biological goals of abundance, productivity, spatial structure, and diversity. While the State Water Board mentions that contributions to productivity may include "meeting measures of quality and quantity of spawning and rearing habitat, fry production, and juvenile outmigrant survival to the confluence of each tributary to the LSJR," they provide no evidence from literature supporting a link between instream flow levels and these biological measures.

In particular, the two criteria of spatial structure and diversity are unlikely to be influenced by proposed adaptive methods of shifting % unimpaired flow. The VSP criterion of spatial structure reflects how abundance is distributed among available or potentially available habitats, with populations that are more geographically widespread able to better survive unpredictable, stochastic events (Good et al. 2005). However, it is unclear how the State Water Board's proposed adaptive management plan of altering % unimpaired flow would influence the spatial structure of salmonids. Without making new habitats assessable through habitat restoration or barrier removal, changes to flow levels alone is unlikely to achieve this biological goal. Therefore, it is misleading to use spatial structure as a biological goal of flow prescriptions unless non-flow measures are explicitly integrated with flow measures. While the program of implementation describes possible non-flow measures that could be conducted by other parties, the program of implementation fails to actually couple flow measures with necessary non-flow measures. The State Water Board's proposed flow measures cannot reasonably be expected to improve the viability of native species if other factors controlling viability are not concurrently addressed.

The VSP criterion of diversity is unlikely to be influenced by the proposed adaptive management strategy. Genotypic and phenotypic diversity are important in that they allow species to use a wide array of environments, respond to short-term changes in the environment, and survive long-term environmental change (Good et al. 2005). Diversity refers to variation in traits such as run timing, age structure, size, fecundity (birth rate), morphology, behavior, and genetic characteristics (NMFS 2014). While alterations to the flow regime alone may influence components of diversity such changes in flow pulses influencing run timing, or average size of juvenile migrants, it is unlikely that other components of diversity could be influenced by flow alone. How will flow alterations alone influence age structure, or fecundity, or morphology, or genetic characteristics? This needs to be discussed by the State Water Board. And like spatial structure, expecting flow prescriptions alone to truly enhance the diversity of salmonid populations is a set up for failure, and will lead to adaptive management measures that will unlikely reach biological goals.

Without clear, supported hypotheses linking proposed adaptive flow prescriptions to each of the 4 VSP criteria, using the VSPs as biological goals is misleading and sets the adaptive management plan up for failure. Instead, biological goals should be developed that can be directly linked to the proposed adaptive management measures as supported by scientific literature or new analyses. And it is critical that the State Water Board disclose the difference between correlative relationships and cause and effect relationships. For example, while increased flows may cause increased inundation of floodplains, increased flows cannot be directly attributed for increasing productivity. Using biological goals that cannot be directly linked to flow actions is dangerous, as it could lead to iterative increases in flow levels that do not help meet biological goals, and instead waste water that could otherwise have supported other beneficial uses.

An "unimpaired flow" regime implemented without careful consideration of the biological and ecosystem processes that the flows are intended to support is unlikely to provide the intended

protection for fish and wildlife beneficial uses. Also, an unimpaired flow regime implemented without consideration of how the hydrological system has been altered or without consideration of other habitat needs of native fish populations is unlikely to be an effective approach to restoring and maintaining native fish populations. In addition, factors other than flows or exports are having a dramatic impact on salmon survival in the southern Delta. The survival levels are so low now, that even in the high flow years of 2005, 2006 and 2011 these survival rates (likely altered by increases in predation by invasive species) are not high enough to sustain salmon abundance. In fact, the Recirculated SED's technical report quotes the Independent Panel Review of the VAMP studies with the following: The review panel concludes that "'the very low recent survival rates seem unlikely to be high enough to support a viable salmon population, even with favorable conditions for ocean survival and upstream migration and spawning success for adults' (Hankin, et al. 2010)." (Recirculated SED, App. C, at p. 3-39.)

4. The Proposed "Adaptive Management" Approach Is Flawed

(a) The Proposed Flow Regime Fails To Implement The Draft Narrative Flow Objective And Improperly Defers Critical Components Of The Program Of Implementation

Under the proposed program of implementation, the Executive Director would have the authority to change the timing and magnitude of flows within the February – June period each year, provided the total quantity of water dedicated to instream flow releases is not less than the quantity that would be have been dedicated under a percent of the hydrograph approach each year. (Recirculated SED, App. K, at pp. 29-36.) A newly formed Stanislaus, Tuolumne and Merced Working Group ("STM Working Group") made up of the fishery agencies (DFW, NMFS, and USWS) and water users would make recommendations to the Executive Director regarding how he or she should schedule each year's reservoir releases. (*Ibid*.) The San Joaquin River Monitoring and Evaluation Program would be responsible for monitoring, implementing special studies, and evaluating the performance of the flow management strategy on the viability of native salmonid populations, including the abundance, spatial extent, diversity, and productivity of fall-run Chinook salmon and steelhead. (*Ibid.*) The practical result of the proposed "adaptive management" structure is that it changes the program of implementation into something other than a percent of the hydrograph approach. Rather than mimicking the actual hydrograph during the February-June period each year, the program of implementation would function more like a water bank where withdrawals can be made at any time throughout the spring (February – June). The total quantity of water available for additional flows is established by the percent of the hydrograph approach, but the timing of flows is established by the Executive Director and the STM Working Group. In fact, the program of implementation allows a portion of the February-June unimpaired flow water bank to be shifted outside of the February-June period, to be released later in the year. (*Id*. at p. 30.) Such an approach results in a failure to satisfy the proposed objective of maintaining "…flows that more closely mimic natural hydrographic conditions…" or the proposed objective of maintaining a "percent of unimpaired flow between 30%-50%" from February through June (*Id.* at p. 18.) The flows will not be targeting more natural conditions, rather the flows will be whatever the Executive Director orders each year.

Not only does the water budget approach not satisfy the narrative objective of "mimic natural hydrologic conditions…" but the adaptive methods to determine the annual schedule for releases is left to future annual decisions, making it impossible to review their approach. The State Water Board only states that an Executive Director along with the STM Working Group will determine the release schedule on an annual basis, and provides no detail on the possible ecological mechanisms that would inform these release schedule changes. The SED provides no discussion of the types of habitat and biological monitoring data, rationale, or analyses that would be used as the technical basis for modifying the instream flow schedule within a year. The State

Water Board needs to provide the actual suite of functional flows that the STM Working Group and Executive Director could draw from to inform the year's release schedule, explicitly linking these functional flows with the ecosystem processes they are intended to support.

The program of implementation states that the biological goals for the flow objectives "will specifically be developed for abundance; productivity as measured by population growth rate; genetic and life history diversity; and population spatial extent, distribution, and structure." (Recirculated SED, App. K at 33.) However, as suggested by the Delta ISB (2015), a critical component of adaptive management is identifying causal mechanisms between flow and other drivers on fish vital rates to create "specific outcome expectations for management actions." Unfortunately, the program of implementation and SED do not perform the critical step of linking management actions to biological goals. Instead of leaving the adaptive management process up to a future, ambiguous process, the State Water Board should develop explicit hypotheses linking specific functional flows to fish responses informing a transparent, adaptive management process.

(b) The Proposed "Adaptive Management" Is Not True Adaptive Management As Used In A Scientific Framework

Adaptive management in a scientific context is something very different than what is being proposed in the POI. The approach outlined in the proposed POI is basically water balance accounting and re-allocation of instream flows among months to address hydrologic variability within a year. Such an approach is not true adaptive management. In the proposed adaptive management structure, decision-making is not linked to a rigorous study plan of hypotheses testing and monitoring. There is no process and no thresholds or performance measures for determining when a change in the implementation measure is scientifically appropriate, and no specifically articulated standards or criteria for determining whether actions have been effective.

Adaptive management provides a means for carrying out and assessing alternative management actions in the face of uncertainty. The adaptive management process, when appropriately implemented, should facilitate testing of management alternatives, evaluation of outcomes, iterative modifications of management actions as new information is developed through monitoring and experimentation, and learning. Adaptive management cannot be used to compensate for a lack of knowledge, the variability and complexity of ecological systems and biological processes affecting salmonid population dynamics, or underestimating sources of uncertainty including socio-political uncertainty.[5] If the State Water Board is going to pursue adaptive management, it needs to follow a true scientific model of monitoring, special studies, and hypotheses testing.[6] To accomplish true adaptive management, the State Water Board must develop a detailed adaptive management plan and associated experimental design for monitoring the performance of the instream flow strategy on metrics of salmonid viability before it adopts an amendment to the Bay-Delta Plan. (*See POET, LLC, supra,* 218 Cal.App.4th at p. 740 [agency implementing a certified regulatory program must specify "what tests will be performed and what

[5] Under the California Environmental Quality Act ("CEQA") (Pub. Resources Code, § 21000 et seq.), a regulatory plan designed to improve environmental conditions must include objective performance criteria by which to measure success. (*POET, LLC v. California Air Resources Board* (2013) 218 Cal.App.4th 681 [agency implementing a certified regulatory program cannot defer formulation of plan details or mitigation measures without committing to specific performance standards to achieve stated objectives].)

[6] The Recirculated Draft SED acknowledges that "[a] comprehensive monitoring, special studies, evaluation, and reporting program is necessary to determine compliance with the LSJR flow objectives, inform adaptive implementation, investigate the technical factors involved in water quality control, and identify potential needed future changes to the LSJR flow objectives," but defers any description of or commitment to biological goals, adaptive methods procedures, and measures to achieve, monitor, and evaluate compliance with flow objectives until long after the State Water Board adopts amendments to the Bay-Delta Plan. (Recirculated Draft SED, at pp. 3-17 – 3-18.) It also suggests that approval of these critical components of the Bay-Delta Plan could be delegated to the Executive Director. (*Ibid.*) By deferring and delegating these important responsibilities of the State Water Board, the Recirculated Draft SED violates CEQA.

measurements will be taken" to demonstrate progress toward achieving stated objectives].) Such actions cannot be deferred. (*Ibid*.)[7]

The State Water Board's Program of Implementation appears to be "Adaptive Management Lite" (AM-Lite). AM-Lite is a restricted version of adaptive management that according to Ruhl and Fischman (2010) "often fails due to management, implementation and planning problems." They continue describing AM-Lite as *ad hoc* contingency planning done for projects. This is because AM-Lite lacks the necessary elements to be adaptive management proper: precise goal definition, decision-support models, active experimentation with *a priori* quantitative predictions or "performance standard setting" (Fischman and Ruhl 2015), monitoring, and adjustment of management strategy based upon the outcome of the process (Holling 1978; Walters 1986).

The State Water Board should develop explicit hypotheses linking specific functional flows to fish responses informing a transparent, adaptive management process. The Delta Independent Science Board (Delta ISB) offers several recommendations on scientific strategies to benefit adaptive management of Delta fishes (Delta ISB 2015). The Delta ISB concludes that an improved quantitative understanding of causal mechanisms is required for effective adaptive management and for creating specific outcome expectations for management actions. The Delta ISB (2015) believes in restoring specific aspects of the flow regime that support key ecosystem functions and drive geomorphological and ecological processes. Instead of relying on simple regressions of annual abundance with annual measures of flow, specific functional flows hypothesized to benefit salmonids (e.g. specific peak flow events meant to support specific life stages) should be evaluated using a life cycle modeling approach that links hydrodynamics and water quality with salmon life history. Instead of simply mimicking a natural flow regime, the Delta ISB (2015) believes that a more effective approach is to restore specific aspects of the flow regime that support key ecosystem functions and drive geomorphological and ecological processes. These functional flows are based on field observations of life stages and computer models of hydrodynamics, habitat, and ecological conditions for different flows (Delta ISB 2015). The advantage of this mechanistic approach is greater ability to explain cause-effect and lead to new knowledge through the adaptive management process. This approach also provides a more tailored use of limited water resources, targeted towards areas of greater certainty regarding expected benefits of particular flows.

Similar to Delta ISB recommendations, Yarnell et al. (2015) provides similar support for applying a functional flows approach when developing flow schedules in modified riverscapes. Yarnell et al. (2015) argues that simply mimicking natural flows will be unsuccessful without also triggering key functional processes such as wet-season initiation flows, peak magnitude flows, recession flows, dry-season low flows, and interannual variability. Yarnell et al. (2015) states that "considering the interaction of hydrologic, geomorphic, and ecologic processes and the functions

[7] An agency implementing a certified regulatory program may rely on CEQA's tiering principles when considering a proposed program, plan, or policy, and the Recirculated Draft SED states that the State Water Board has done so for the draft amendments by preparing a programmatic environmental analysis. (Recirculated Draft SED, at p. 1-3; see *Conway v. State Water Resources Control Board* (2015) 235 Cal.App.4th 671, 680.) A program-level document may sometimes forego a project-level analysis of activities that are specific to later phases and will be analyzed as part of a subsequent CEQA process. Tiering does not permit the agency to defer formulation of *critical elements of the plan it is approving* to a later date, however, particularly where, as here, the agency does not anticipate further CEQA review of plan changes or subsequently developed information, and suggests instead that they may be delegated to its staff. (*Vineyard Area Citizens v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 431 ["stating information will be provided in the future" does not comply with CEQA]; *see* Recirculated Draft SED, at pp. 3-17 – 3-18.) Tiering is not a device for deferring identification of impacts that adoption of a proposed plan can be expected to cause. (*Stanislaus Natural Heritage Project v. County of Stanislaus* (1996) 48 Cal.App.4th 182, 199.) Fundamental and general matters – such as the biological goals that are the fundamental objectives of the draft amendments – must be identified and addressed in the first tier EIR. (*Ibid.*; *Vineyard, supra,* 40 Cal.4th at p. 431.)

they serve is more likely to result in e-flow targets that better support self-sustaining ecosystems that are inherently diverse and adaptive." Therefore, as supported by the Delta ISB, a comprehensive, integrative, and well planned scientific approach focused on processes, drivers, and predictions is needed to aid adaptive management and to predict how future changes might affect fishes.

This more integrative science approach recommended by the Delta ISB (2015) requires the creation of collaborative, open-source hydrodynamic models developed for the purpose of making testable predictions of biological responses to functional flows. Such a modeling approach would provide an operational tool for adaptive management and forecasting biological outcomes of water decisions. Modeling will require components of regional climate (hydrology), hydrodynamics, water quality, food availability, and physiological and habitat requirements at various fish life stages across different fish species (Delta ISB 2015).

5. The Proposed Program Of Implementation Would Result In Future Amendments To The Water Quality Control Plan Without The Procedures Required By Law

The proposed POI would effectively allow for amendments of the water quality control plan through an adaptive management program, without complying with the procedural requirements of Porter-Cologne and the APA that are applicable to the promulgation of a water quality control plan. The proposed POI states that the "LSJR flow objectives for February through June shall be implemented by requiring 40 percent of unimpaired flow, based on a minimum 7-day running average, from each of the Stanislaus, Tuolumne, and Merced Rivers. *This required percentage of unimpaired flow, however, may be adjusted* within the range allowed by the LSJR flow objectives through adaptive methods detailed below.." (Recirculated SED, App. K, at p. 29, italics added.) The proposed POI allows a "Stanislaus, Tuolumne and Merced Working Group" to propose annual adaptive management of flows during the February through June period and the adaptive management allows a "flow pattern different from that which would occur by tracking the unimpaired flow percentage . . .." (*Id*. at p. 30.) In addition, the proposed POI allows the State Water Board or the Executive Director of the State Water Board, to approve modifications to the required base flow and percentage of unimpaired flows based on subsequently produced information. (*Id*. at pp. 30-31.) These provisions of the POI effectively allow the State Water Board and the Executive Director to amend the water quality control plan to require different base flows and a different flow regime. This approach not only improperly delegates authority to the Executive Director and STM Working Group, but denies the public procedural protections afforded by law.

Porter-Cologne and the APA require the State Water Board to provide an opportunity for public notice and comment before the State Water Board adopts any amendment to a water quality control plan. Porter-Cologne requires the State Water Board to provide notice of a public hearing and to hold a public hearing regarding a proposed water quality control plan, before adopting any plan. (Wat. Code, § 13244.) In addition, the State Water Board must comply with the APA procedures applicable to rulemaking prior to the adoption or amendment of a water quality control plan. (23 C.C.R. §§ 649.1, 649(a).) The APA requires that a state agency permit "both oral and written statements, arguments, or contentions" at the public hearing for the rulemaking proceeding and the state agency "shall consider all relevant matter presented to it before adopting, amending, or repealing any regulation." (Gov. Code, § 11346.8, subd. (a).) The APA also prohibits a state agency from adopting or amending a regulation which has been changed from that which was originally made available to the public, unless the change is "nonsubstantial" or "sufficiently related to the original text that the public was adequately placed on notice that the change could result from the originally proposed regulatory action." (Gov. Code, § 11346.8, subd. (c).) These procedural provisions are intended to provide the public with prior notice and an opportunity for

comment, before a water quality control plan is amended or adopted. They are also intended to allow the State Water Board (not the Executive Director through a delegation of power)[8] the ability to make informed decisions. The proposed POI contemplates an "adaptive management" process that would effectively deny the public important rights and usurps the State Water Board's responsibility to establish objectives, by allowing the flow regime to be determined and approved annually, at the discretion of the Executive Director and the STM Working Group. Such an approach effectively allows the water quality control plan to be amended each year. Such an approach is contrary to the procedures provided for in Porter-Cologne and in the APA.[9] The annual changes would amount to unlawful, underground regulations.

II. SPECIFIC COMMENTS ON SUBSTITUTE ENVIRONMENTAL DOCUMENT

The Public Water Agencies submitted detailed comments on the proposed draft amendments as well as on the draft SED, but these comments have received insufficient attention from the State Water Board in its environmental analyses. The Public Water Agencies continue to have serious concerns with the draft amendments and the Recirculated Draft SED, because fundamental requirements of CEQA have not been met and the SED fails to provide the necessary analysis and scientific information to develop water quality objectives.

A. Fundamental Problems With The SED Undermine The Environmental Analysis

An SED prepared in lieu of an EIR is an informational document designed to provide agencies and the public with an understanding of a proposed plan or project sufficient to assess its environmental consequences, and is subject to the substantive provisions of CEQA. (Pub. Resources Code §§ 21002, 21080.5; CEQA Guidelines, § 15250; *City of Morgan Hill v. Bay Area Air Quality Management District* (2004) 118 Cal.App.4th 861, 874-875.) [10] Fundamental flaws

[8] The POI allows the Executive Director of the State Water Board to independently approve changes within the 30-50% unimpaired flow range unimpaired flow regime based on subsequently produced information or requests by the newly formed STM Working Group. (Recirculated SED, App. K, at pp. 30-31.) The POI also allows for management of the flows as a block of water, that can be adjusted to a different flow pattern than the unimpaired flow pattern, and allows for shifting of the releases outside of the February-June period. (*Id*.) Such an approach effectively allows for amendments to the water quality control plan, without any further review or consideration by the State Water Board. This would be an improper delegation of the State Water Board's water quality planning powers and duties. (*See Cal. Assn. of Nursing Homes etc. Inc. v. Williams* (1970) 4 Cal.App.3d 800, 813 [agency's incorporation of standards developed outside of the rule-making process without independent consideration of the underlying evidence and without public or judicial access to that evidence transgresses fundamental demands for the adoption of administrative regulations].) In fact, the Water Code expressly prohibits a regional water quality control board from delegating any of its powers and duties related to the issuance or modification of any water quality control plan to its executive officer. (Wat. Code, § 13223, subd. (a).) The same prohibition should apply when the State Water Board is modifying or issuing a water quality control plan pursuant to Water Code section 13170.

[9] An approach that effectively allows the water quality control plan to be amended each year also violates CEQA by impermissibly delegating the State Water Board's duty to consider the environmental effects of subsequently developed information or changes to the plan. (*See POET, LLC, supra,* 218 Cal.App.4th at p. 731 [agency violated "a fundamental policy of CEQA" by separating decision-making authority on its regulatory program from its duty to conduct environmental review]; *Kleist v. City of Glendale* (1976) 56 Cal.App.3d 770, 779 [separation of the approval function from the environmental analysis function improperly attempts to insulate the agency "from public awareness and possible reaction" to the choices made].)

[10] The exemption for certified regulatory programs provided by Public Resources Code section 21080.5 is not a blanket exemption from CEQA. A certified regulatory program remains subject to the provisions of CEQA outside the scope of the exemption, including CEQA's broad policy goals and substantive standards. (*POET, LLC, supra,* 218 Cal.App.4th at p. 731; see Cal. Code Regs., tit. 23, § 3777(b) [State Water Board regulations describing minimum required contents of a substitute environmental document].) These include the fundamental duties set forth in Public Resources Code sections 21000 and 21002 to identify a project's adverse environmental effects, to mitigate those effects through adoption of feasible alternatives or mitigation measures, and to justify its action based on specific economic, social, or other conditions. (*Sierra Club v. State Board of Forestry* (1994) 7 Cal.4th 1215; *see also* CEQA Guidelines, § 15250.) In short, the State Water Board's SED must include the same types of environmental information as an EIR, including a

continue to pervade the Recirculated Draft SED's project description and objectives, the scope and methods of impact analysis, the selection and analysis of alternatives, and the lack of substantial evidence to support stated conclusions.[11] These flaws result in a misleading document that fails to serve CEQA's informational purposes.

B. Legal And Analytical Defects Of The Substitute Environmental Document Related To The Proposed Lower San Joaquin River Flow Objectives And Program Of Implementation

1. The SED's Description Of The Draft Amendments And Program Of Implementation Is Indefinite And Unstable

Programmatic CEQA documents must include "accurate, stable and finite" project descriptions. (*Rio Vista Farm Bureau Center v. County of Solano* (1992) 5 Cal.App.4th 351, 370 [programmatic analysis requires "[a]n accurate, *stable* and *finite* project description" because it "is the *sine qua non* of an informative and legally adequate" CEQA analysis] (italics added).) It allows the lead agency to identify the proper environmental baseline, to evaluate the "no project" alternative, to develop a range of reasonable and viable alternatives, to consider mitigation measures, and to balance a project's benefits[12] against its environmental costs. (*County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 192-193.) Although a programmatic analysis may contain a more general project description than a project-level document, it nevertheless must be stable and finite such that the public and other agencies have a meaningful opportunity to comment on the actual plan that will be adopted and implemented. The SED's project description of the draft amendments and program of implementation is not stable and is subject to change. (Recirculated Draft SED, Chapter 3; see *id*. at pp. ES-11 – 21.) The SED violates CEQA because it does not define parameters or describe the range of possible flow patterns the Executive Director may order in the future; it does not specifically articulate the biological goals or performance criteria such actions are intended to meet; nor does it analyze the reasonably foreseeable environmental impacts of those potential flow patterns. Relying on a "curtailed, enigmatic or unstable definition of the project," as the SED does here, stands as the paradigm of legal error under CEQA, because it "draws a red herring across the path of public input." (*County of Inyo, supra,* 71 Cal.App.3d at p. 199.)

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description of the activity and analysis of impacts, mitigation measures, alternatives, and cumulative impacts. (*Friends of the Old Trees v. Dept. of Forestry & Fire Protection* (1997) 52 Cal.App.4th 1383, 1393.)

[11] Environmental documents prepared for certified regulatory programs must use scientific and other empirical evidence to support their conclusions. (See *Ebbetts Pass Forest Watch v. Dept. of Forestry & Fire Protection* (2008) 43 Ca.4th 936, 943-945.) Just as in an environmental impact report, a lead agency's conclusions in an SED must be supported by substantial evidence – facts, reasonable assumptions predicated on facts, and expert opinion supported by facts. (CEQA Guidelines, § 15384; *Laurel Heights Improvement Association v. Regents of the University of California* (1988) 47 Cal.3d 376, 393.) Substantial evidence does not include argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence that is not credible. (Pub. Resources Code, §§ 21080(e), 21082.2(c); CEQA Guidelines, § 15384.) As is discussed in detail in the sections below, this recirculated environmental document, like the Draft SED, lacks supported analysis and evidence in support of its assumptions and conclusions regarding anticipated effects and outcomes likely to result from implementation of the draft amendments.

[12] As is discussed in further detail below, the Recirculated Draft SED assumes that the draft amendments will result in long-term environmental benefits without identifying any standards, criteria, or biological goals by which to measure whether and to what degree any such benefits occur. The true extent and likelihood of the proposed action's assumed benefits are highly uncertain. Clear identification of objectives and the ways in which the proposed action is expected to achieve them is crucial to an informative CEQA analysis. Without specifically articulated biological goals, performance standards, or other meaningful project objectives against which to compare anticipated outcomes of the proposed action and a range of potentially feasible alternatives, the SED fails to meet CEQA's basic requirements. (Pub. Resources Code, § 21061; CEQA Guidelines, §§ 15002(a); 15124(b), 15126.4, 15126.6.) "[F]ailure to provide enough information to permit informed decision-making is fatal." (*Napa Citizens for Honest Government v. Napa County Board of Supervisors* (2001) 91 Cal.App.4th 342, 361.)

2. The SED Fails To Provide A Sufficient Analytical Link Between Flow Function And Expected Benefit For Salmonids And The Proposed Implementation Program

"An EIR may not define a purpose for a project and then remove from consideration those matters necessary to the assessment of whether the purpose can be achieved." (*County of Inyo v. City of Los Angeles* (1981) 124 Cal.App.3d 1, 7-9.) The SED violates this basic CEQA principle by failing to provide a legally or scientifically sufficient analytical link between the proposed flow objective and implementation flows, and potential flow-derived benefits for salmonids. The fundamental basis of the flow objective is that an increased magnitude of instream flows that mimic actual seasonal hydrologic conditions during the later winter and spring each year is predicted to result in an increase in the abundance and survival of juvenile and adult Chinook salmon and steelhead. However, the SED does not contain an analysis establishing that the salmonid population viability factors (e.g., abundance, spatial extent or distribution, genetic and life history diversity, and productivity) can be achieved by providing flows that mimic the natural hydrograph. Even if this analytical connection had been made, it has not been sufficiently established that the implementation of the proposed SED flow alternatives would provide "natural" flows under which the fish evolved and were adapted (e.g., the relative magnitude, duration, timing, and spatial extent of historic flows).

(a) The Available Science Does Not Support The Conclusion That An Unimpaired Flow Approach Will Ensure The Reasonable Protection Of Fish And Wildlife

Appendix C of the SED describes two general categories of expected benefits from the percent of unimpaired flow approach: (1) additional flow is needed to significantly improve production (abundance) of fall-run Chinook salmon [upstream]; and (2) the primary influence on adult abundance is flow 2.5 years earlier during the juvenile rearing and outmigration life phase (Recirculated SED, App. C, at p. 3-30.) However, the SED provides only a high level and incomplete review of the literature regarding the unimpaired flow management concept, and fails to link the flows actually being proposed with the flows studied in the literature. (Draft Revised SED, App. C, Section 3). In addition, the SED fails to acknowledge the high level of uncertainty and highly variable responses within aquatic communities under the unimpaired flow strategy and the effects of factors such as habitat modifications (e.g., levee construction that alters floodplain inundation, channelization, loss of wetland and riparian vegetation, water storage by dams, cold water pool management and exposure to seasonally elevated water temperatures particularly during the late spring, summer, and fall, groundwater extraction, gravel mining, loss of spawning gravels and habitat complexity, etc.), changes in exposure to contaminants, and changes in biological relationships (e.g., increased risk of predation, influence of hatchery operations, competition for limited suitable spawning and rearing habitat, changes in macroinvertebrate prey composition and abundance, invasive species, etc.). The SED fails to identify a scientific method for evaluating the success or failure of the unimpaired flow approach in a complex ecosystem with many factors affecting fish viability.

Appendix C assumes that all increases in flow will provide measureable improvements in species viability; despite the fact the related literature explains that this is an inappropriate assumption. The literature explains ecosystem response to increased flows are complicated, not a monotonic response to flow alone. As asked and answered in Poff, *et al.* (1997):

> Can reestablishing the natural flow regime serve as a useful management and restoration goal? We believe that it can, although to varying degrees, depending on the present extent of human intervention and flow alteration affecting a particular river [emphasis added].

The literature further explains that it cannot be assumed that additional flow will always provide species benefits. Poff and Zimmerman (2010) reviewed 165 papers related to the natural flow regime. A narrative summary of the reported results from the synthesis of available scientific literature by Poff and Zimmerman (2010) strongly corroborated previous, less comprehensive, reviews that document highly variable ecological responses to all types of flow alteration. The literature review by Poff and Zimmerman (2010) revealed some sensitivity of different ecological groups to alterations in flow magnitudes, but consistent robust statistical relationships were not detected between flows and many important biological responses of the aquatic community. The Poff and Zimmerman (2010) results revealed:

> Macroinvertebrates showed mixed responses to change in flow magnitude, with abundance and diversity both increasing and decreasing in response to elevated flows and to reduced flows. Fish abundance, diversity and demographic rates consistently declined in response to both elevated and reduced flow magnitude. Riparian vegetation metrics both increased and decreased in response to reduced peak flows, with increases reflecting mostly enhanced non-woody vegetative cover or encroachment into the stream channel. [emphasis added.]

Poff and Zimmerman (2010) explained, "Given the alteration of flow regimes is typically confounded with other environmental factors, we would not necessarily expect unambiguous relationships between single measures of flow alteration and ecological response." These confounding relationships have been observed by other researchers as well. Bunn and Arthington (2002) describe the uncertainties associated with attempting to restore "natural" flow to promote ecological restoration.

> In writing this review, we often encountered reports of river systems affected by multiple stressors and were unable to definitely separate the impacts of altered flow regimes from those of the myriad of other factors and interactions. How much of an observed decline in species diversity can be attributed directly to modified flow compared to diffuse inputs of nutrients and contaminants? A similar problem occurs in our attempt to unravel the cause and effect of exotic species on aquatic diversity. Is an observed decline in native fish species the result of a modified flow regime or direct impact of an introduced species (or both)? Ecological science is not yet able to answer these questions, important as they are.
>
> Ecologists still have much to learn about the ecological significance of individual flow events and sequences of events, and descriptive science can take us only so far in unraveling these linkages. The advice from aquatic ecologists on environmental flows might be regarded at this point in time as largely untested hypotheses about the flows that aquatic organisms need and how rivers function in relation to flow regime. [emphasis added.]

Similar concerns regarding the relationship between flow alteration and ecological response to those described by Bunn and Arthington (2002) have been identified in the estuary and Delta. Bennett and Moyle (1996) hypothesized that non-native fish species are better adapted to the conditions now found in the Delta than are native fish species. The Bennett and Moyle (1996) hypothesis is supported by the observations of Feyrer and Healey (2003) who found that non-native fish species are numerically dominant in the south Delta compared to native species. Bennett and Moyle (1996) identified six mechanisms that contribute to declining fish populations: 1) transport and entrainment, 2) advection from preferred habitats, 3) effects of invading species, 4) primary production and food web dynamics, 5) dilution/flushing of toxic compounds, and 6)

quantity and quality of shallow-water habitat. They argued that several mechanisms may control recruitment in any given year thus it was futile to promote any one of these mechanisms solely.

These studies explain why the State Water Board cannot rely on a percent of the hydrograph approach without also considering the relative success of those efforts in meeting the desired biological goals and functions, and the potential for success in the San Joaquin River system and south Delta. The San Joaquin River and the southern Delta are highly altered systems, both physically and ecologically, and the relationships between flows and habitat functions for salmonids are no longer the same as those during historic conditions.

(b) The SED Fails To Provide An Integrated Analysis Of Flow In An Ecosystem Context That Evaluates Non-Flow Stressors

The purpose of Chapter 16, according to the SED (p. 16-1), is to evaluate indirect actions other than flow-related measures. However, Chapter 16 fails to analyze the relative importance of particular non-flow measures to fish viability and thus fails to provide the State Water Board with the information necessary to develop water quality objectives and a program of implementation that can provide for the reasonable protection of beneficial uses.

The SED does not provide an integrated evaluation of all actions that might benefit listed fish species and insure the beneficial use of fish and wildlife populations is conserved. Such an analysis could include:

- identification of non-flow actions essential to recovery of listed migratory fish species;
- development of functional flow criteria designed to meet specific life history stage objectives for each species of interest;
- development of alternative functional flows and non-flow action combinations;
- impact analysis of each of the alternatives;
- salmon population modeling regarding the expected outcome of each alternative for key response variables;
- a cost analysis of each of the alternatives and a predicted benefit: cost analysis;
- an adaptive management approach that identifies hypotheses to be tested and special studies to remove/reduce key uncertainties.

If this integrated evaluation approach was used then the State Water Board would be provided with a range of alternatives that might all contribute to recovery of migratory fish populations. In addition, this integrated approach and effectiveness and cost analyses would provide a sound basis for the selection of a management strategy.

In the Executive Summary, the State Water Board acknowledges the concern expressed that its "proposal for protecting fish and wildlife is 'flow-centric.'" (SED, p. ES-73). However, the State Water Board's response to this criticism is to provide recommended non-flow actions that "could improve conditions for fish and wildlife in the plan area." *Id.* The result of this approach is that non-flow measures that are critical to increasing the viability of fish are largely left unexamined and deferred, while simultaneously, water is taken away from other beneficial uses in the name of improving fish viability. But simply dumping more water into the rivers is not a responsible or scientifically-defensible approach to satisfying the requirement to provide reasonable protection of beneficial uses. An assessment of the role of non-flow measures in achieving the biological goals of the State Water Board's "proposal" is essential to developing reasonable flow measures that can contribute to a comprehensive approach to ecosystem management and fish recovery.

(c) The SED's "Analyses Of Benefits To Native Fish Populations From Increased Flow between February 1 And June 30" Is Inadequate And Misleading

Chapter 19 of the SED is dedicated to providing analyses of the potential benefits to native fish populations from the proposed flow objective's increased flows. The analyses is presented is not scientifically defensible and is misleading in its presentation.

While the SED provides modeled flow analyses of floodplain inundation under the different alternatives in Section 19.3 of Chapter 19, key parameters such as duration, timing, and water temperature that are critical to link modeled floodplain inundations to the fish populations that may benefit are not incorporated. Quantifying the frequency or magnitude of floodplain inundation without considering the usefulness of those inundation events for supporting fish populations overestimates the benefit of floodplain inundation and provides an inaccurate comparison between alternatives.

Inundated floodplain habitat requires time for primary production to occur and subsequent colonization of macroinvertebrates for inundated habitat to provide rearing benefits for juvenile fishes. For example, Grosholz and Gallo (2006) found that zooplankton on the Consumnes River did not reach a maximum biomass until 2–3 weeks after disconnection with the river. This lead Grosholz and Gallo (2006) to recommend that floodplain restoration in the Central Valley consider management strategies that would ensure repeated flooding every 2–3 weeks during periods that would best match the peaks in abundance of native fishes. Therefore, when calculating the amount of floodplain inundation occurring across the various alternatives in Section 19.3, the State Water Board should only be enumerating habitat that has remained inundated for a minimum of two weeks. Without providing this threshold, the State Water Board is counting floodplain habitat that may only be inundated for a few days or less as productive rearing habitat for juvenile fish. This leads to an overestimation of the potential benefit of the different flow alternatives on juvenile fish rearing.

In addition to floodplain duration, the timing of when the modeled floodplain habitat inundates needs to be related to the life history timing of those fish populations utilizing the habitat to avoid overestimating floodplain habitat benefits for rearing fish. Each run and population of salmonids that emigrate out of the San Joaquin River has different outmigration timing. Hallock *et al.* (1961) found that juvenile steelhead in the Central Valley migrate downstream during most months of the year, but the peak emigration period occurred in the spring, with a much smaller peak in the fall. Fall-run Chinook salmon juveniles typically emerge from the gravel in December through March and rear in fresh water for 1-7 months, usually moving downstream into large rivers within a few weeks (Williams 2010). Future populations of spring-run Chinook salmon are expected to behave similarly to spring-run juveniles in Butte Creek, CA, that move downstream primarily during December, January, and February (Ward et al. 2003). Therefore, the floodplain modeling conducted by the State Water Board should calculate the magnitude of floodplain inundation that actually would be available for rearing of each salmonid run by overlaying modeled floodplain inundation with the timing of each salmonid run. Rotary screw trap data of juvenile salmonids is available for each tributary of the San Joaquin River and could be used to compare to floodplain inundation timing.

Finally, the State Water Board's floodplain modeling should also model water temperatures to ensure that modeled inundated habitat is suitable for rearing. The San Joaquin River Basin populations of Chinook Salmon are the southernmost of its species, making them especially susceptible to stress and mortality due to elevated water temperatures (Moyle 2002). Therefore, water temperatures need to modelled along with flows in order to estimate rearing habitat that

meets the suitability requirements of juvenile salmonids. Without considering temperature, the State Water Board is overestimating floodplain habitat available for rearing.

Salmon Simulater Model

The Salmon Simulater (SalSim) model documentation (AD Consultants 2014) provides a list of assumptions and uncertainties inherent in SalSim and its implementation for the San Joaquin River. SalSim makes one assumption that is unreasonable:

- Assumption 5 is that juvenile migration rates are similar during turbid storm events compared to non-storm days. This is not supported by the literature: 1) Atlantic salmon smolts initiate migration after storm events (McCormick et al. 1998) and 2) Chinook salmon smolts in the Sacramento River show a strong positive relationship between turbidity and movement rate (Michel et al. 2012).

It is impossible to gauge how important this assumption is to the outcome of the model.

SalSim also has some uncertainties that should incorporate known information into the model (Uncertainty 7) or address drivers in the model (Uncertainty 22):

- Uncertainty 7: What are juvenile survival rates without the HORB (Head of Old River Barrier)? This is not an uncertainty. There are numerous estimates of juvenile survival rate when the HORB was not installed using coded wire tags in 1995, 1996, 1998, 1999, 2005 and 2006 (SJRGA 2013: Figure 5-1). And there is an estimate of juvenile survival rate in 2011 when no HORB was installed (SJRGA 2013: Table 5-21) using acoustic telemetry. Clearly, this was not an uncertainty but it was not modeled in SalSim.

- Uncertainty 22 is "Unmeasured environmental drivers." This is a concern because numerous unmeasured variables could have significant impacts on the outcome of the model. This means that the model cannot consider non-flow measures that may be controlling fish survival and abundance.

In addition to the modeling problems caused by unreasonable assumptions and uncertainties that were not addressed, there are substantial problems with model calibration and validation. The model was calibrated using data from the past and the model was developed to provide backcasts, estimates of production in the past. Thus, the similarity between the model simulations of escapement and historical observations (AD Consultants 2014: Figures 63, 65, and 67) are in effect a tautology. A robust statistical validation has not been conducted.

Perhaps the most important point in the SalSim documentation is that the only validation exercise appears to be a simple graphical comparison. That is, there has been no statistical comparison of model backcasts to actual production in each year. Thus, it is impossible to determine if SalSim model outputs are precise predictions of Chinook salmon production under various flow scenarios. A visual evaluation of AD Consultants (2014) Figure 61 suggests there is a range in error from 0 - 25% in escapement for different years. Without a rigorous validation study, it is not possible to assess the usefulness of the SalSim model. For example, in a rigorous validation study an *a priori* threshold for model performance would be provided before model construction commenced. Then, a statistical comparison of the model backcasts to the actual observed values would be made. SalSim output would have to meet the *a priori* threshold before the model and its output could be considered validated. Unvalidated models and theories have long been known to be a detriment to effective salmon management (Hall 1988). Hall (1988)

makes his case regarding theory but it can just as easily be applied to models: "This does not mean that the theorists need to become experimentalists, but rather that any new theory be required to include non-trivial, non-tautological field validation or else suggest experiments or observations that could be done by someone else to (in)validate the theory."

The lack of validation is not an academic problem. It essentially means that the output of the SalSim model cannot be trusted to provide precise enough estimates of salmon escapement for management purposes. Thus, it is incumbent upon the State Water Board to carry out a proper model validation exercise before using the SalSim model for management and policy decision making. And, conclusions from the SalSim modeling can't be relied upon until such a validation takes place. For example, the SED suggests that a seven year model run (1998 to 2004) may be a "better output instead of looking at the full 16-year SalSim time period" (SED, p. 19-85). Then, using the 1998-2004 period, the SED concludes that the SB20%UF (the 20% unimpaired flow run) will produce even less fish compared to the baseline. This reasoning cannot be accepted because the conclusion is provided by a model that has not been properly validated. Thus this "conclusion" cannot be relied upon. And, importantly, this is true of all conclusions drawn from SalSim model runs.

The SED's attempts to predict the effects of increased flows on fish abundance are inaccurate and misleading. (See SED Chapter 19, Section 19.4) The SalSim modeling was done providing backcasts: a prediction of what would have happened in the past if different flow management strategies would have been implemented. However, this modeling relies on past correlations and cannot accurately predict the cause-effect of future flows in a highly altered ecosystem such as the San Joaquin River watershed.

Years of telemetry data from Delta survival studies show that the greatest mortality hotspots occur in the most-tidally driven reaches (least impacted by Delta inflow), providing evidence that changing seasonal flows is unlikely to solve mortality concerns in the Delta. Survival studies summarized by Perry et al. (2016) have shown that survival tends to be higher in the upper reaches of the Delta (less tidally-driven) compared to lower reaches (more tidally-driven). In the Sacramento River, survival rate per kilometer generally declined along a downstream gradient, with lowest survival rates occurring in the interior Delta and the region around Cache Slough (Perry 2010). In the San Joaquin system, survival estimates of juvenile fall-run Chinook Salmon from the region near the Mossdale Bridge to Turner Cut averaged 0.30 for 2008–2012, while survival in all possible routes downstream of the Turner Cut junction to Chipps Island averaged only 0.11 in 2008 and 2010–2012 (Holbrook et al. 2009; Buchanan et al. 2013, 2015; SJRGA 2013). Therefore, the areas with the lowest survival in the Delta occur in the more interior reaches where tidal dynamics drive hydrology. Changes to Delta inflows are unlikely to solve mortality concerns for migrating salmonids in these areas. In the SED, the State Water Board should discuss the potentially limited influence that changes to seasonal flows could have on outmigration survival of salmonids in the Delta.

As recommended by the Delta ISB (2015), a comprehensive, integrative, and well planned scientific approach focused on processes, drivers, and predictions is needed to aid adaptive management and to predict how future changes might affect fishes. The Delta ISB (2015) recommends the creation of collaborative, open-source hydrodynamic models developed for the purpose of making testable predictions of biological responses to functional flows. Such modeling will require components of regional climate (hydrology), hydrodynamics, water quality, food availability, and physiological and habitat requirements at various fish life stages for different fish species (Delta ISB 2015).

The flow prescription approach proposed in the SED is unlikely to succeed. The SED provides no mechanism to test the unimpaired flow approach and its usefulness for fish population recovery. Thus, if migratory fish populations fail to recover under this proposed management policy it will not be possible to determine if the unimpaired flow approach caused the decline or contributed to it. Furthermore, the SED does not provide a sufficient description of the adaptive management process in its Program of Implementation to indicate what will be learned in the event of success or failure.

There is not substantial evidence in the record to support the conclusion that an "unimpaired flow" regime will support the physical and ecological processes necessary to support native fish populations. The SED fails to evaluate "unimpaired flow" in the context of a highly modified ecological system and instead assumes that the "unimpaired flow" approach is necessary to support native fish populations. That assumption is not supported by substantial evidence and fails to account for the complex and inter-related physical and biological characteristics of the San Joaquin River basin and the Bay-Delta ecosystem. The confounding relationships between flows and other environmental factors make the ecological consequences of an "unimpaired flow" regime highly uncertain. The "natural hydrographic conditions" to which native fish species are adapted included a complex and dynamic habitat that has been significantly altered by human actions. An "unimpaired flow" regime will not restore those dynamic habitat functions and it will not mimic "natural" hydrographic conditions.

C. The Alternatives Analysis Is Inadequate To Allow For Informed Comparison

The alternatives analysis is critical to the informational purposes and legal adequacy of an EIR. (*In re Bay Delta Programmatic Environmental Impact Report Coordinated Proceedings* (2008) 43 Cal.4th 1143, 1162-1163; CEQA Guidelines, § 15126.6.) Indeed, the discussion and meaningful consideration of alternatives to the proposed action lies at "the core" of an adequate CEQA review. (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564 [range of alternatives in a CEQA document is intended to provide the public and decision makers with meaningful choices]; *Laurel Heights Improvement Association v. Regents of the University of California* (1988) 47 Cal.3d 376 [CEQA document's major purposes include ensuring that the lead agency thoroughly assesses all reasonable alternatives to the proposed action].) The "public agency bears the burden of demonstrating that, notwithstanding a project's impact on the environment, the agency's approval of the proposed project followed meaningful consideration of alternatives and mitigation measures." (*Cal. Clean Energy Com. v. City of Woodland* (2014) 225 Cal.App.4th 173, 203.) Particularly given the State Water Board's characterization of its approach to the draft amendments as "programmatic" under CEQA, the range of potentially feasible alternatives and the depth of their consideration should be the heart of the SED. (*Ibid.*; CEQA Guidelines, § 15168(b)(1).) Yet, in the SED as drafted, an unduly narrow statement of the project purpose and the lack of meaningful information in the project description and objectives carries fundamental defects forward into the alternatives analysis.

1. The Goals And Objectives Of The Project Are Too Narrowly Drawn And Lead To An Unreasonably Constrained Alternatives Analyses

Under CEQA, the SED "must include a clear statement of 'the objectives sought by the proposed project,' which will help the lead agency 'develop a reasonable range of alternatives to evaluate in the [environmental document] and will aid the decision makers in preparing findings or a statement of overriding considerations, if necessary.'" (*San Joaquin Raptor Rescue Center, supra,* 149 Cal.App.4th at pp. 654-655, quoting CEQA Guidelines, §15124(b).) Project objectives are crucial to proper consideration and analysis of the proposed action, especially in relation to the formulation and evaluation of potential alternatives. The SED's statement of objectives frustrates CEQA's basic purposes because it lacks biological goals or other specifically articulated water

quality objectives against which to compare anticipated outcomes of the proposed action and a range of potentially feasible alternatives. (CEQA Guidelines, § 15124(b); *In re Bay-Delta, supra,* 43 Cal.4th 1143, 1166 [lead agency may not give a project's purpose an artificially narrow definition such that the range of alternatives to the proposed action is unduly constrained]; *County of Inyo v. City of Los Angeles* (1984) 160 Cal.App.3d 1178, 1186 [proposed action cannot be defined to set up "a CEQA turkey shoot"].)

The SED goals and objectives unreasonably limit the alternatives to the months of February through June, limit the alternatives to only three of the tributaries in the watershed (the Stanislaus, Tuolumne, and Merced Rivers); and limit flows to those that "…mimic the natural hydrographic conditions to which native fish were adapted." (Recirculated SED, at pp. 3-1 – 3-3.) A number of alternatives could offer an equivalent or better contribution to improved salmon viability but in a more water efficient and practical (and thus less impactive) manner than unimpaired flow, but were precluded from consideration because of the overly narrow goals and objectives. For example, alternative flow patterns to the "unimpaired flow" regime, as well as non-flow actions such as habitat and floodplain restoration to improve the food web, could provide equivalent or better fishery benefits.[13] (See Baxter et al. 2010: Figure 8; Delta Stewardship Council 2016). To comply with CEQA, the SED must include these options as alternatives and state meaningful project objectives – criteria that link the proposed action and alternatives to achievement of the agency's fundamental purpose to reasonably protect fish and wildlife beneficial uses – as the basis for comparing their impacts and benefits. The SED's calculated selection of a truncated project concept is "not an abstract violation of CEQA," but rather, a failure to proceed "in a manner required by law." (*County of Inyo, supra,* 71 Cal.App.3d at p. 200, quoting Pub. Resources Code, § 21168.5.) The "impermissibly truncated" and unstable project description in the SED also unlawfully skewed the assessment of alternatives.

As drafted, the SED lacks any substantiated evaluation of the impacts or effectiveness of the preferred alternative in relation to meaningful project objectives or to other potential courses of action. (Recirculated SED, at pp. 3-1 – 3-3.) The SED fails to provide any analytical basis for its comparisons of environmental impacts and benefits, and as a result, the SED's range of alternatives and comparison of their relative merits is manifestly unreasonable. *(City of Maywood v. Los Angeles United School District* (2012) 208 Cal.App.4th 362, 420*; see Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692, 730-737 [general qualitative comparisons such as "greater than" or "lesser impacts" than the proposed action are not adequate].) The SED provides no basis for genuine comparison, leaving the public and the decision makers unable to determine whether the draft amendments or alternatives can feasibly accomplish the objectives.

In Appendix K, the State Water Board explains that biological goals will be developed to measure the viability of salmonids. The State Water Board specifies that the biological goals that will inform the adaptive methods will address the four parameters of abundance, productivity, spatial structure, and diversity. While they mention that these goals will be used for adaptive management, the State Water Board never uses these biological goals in their comparisons of alternatives in the SED. Biological goals should be developed and utilized in comparisons of alternatives to determine which alternative best supports the viability of each salmonid population.

[13] As noted above, the Recirculated Draft SED fails to identify any biological goals or performance standards or specifically articulate any other meaningful project objectives against which to compare anticipated outcomes of the proposed action and a range of potentially feasible alternatives. (See Recirculated Draft SED, at pp. 3-1 – 3-3.) According to Chapter 19, Figure 19-13, it appears that the primary benefit of 40-50% unimpaired flow is an increase of approximately 1,100 Fall run Chinook Salmon, a non-listed fish species. (Recirculated Draft SED, Figure 19-13.) The SED violates CEQA because its statement of project objectives and alternatives analysis provide no information as to whether this benefit serves the fundamental project purpose, and no information regarding potential options to achieve the same increase in fish population while avoiding or substantially reducing the environmental impacts of the proposed action. (CEQA Guidelines, §§ 15124(b), 15126.6.)

2. The Draft SED Fails To Analyze Reasonable Alternatives To A Flow Objective

The SED analyzes a single, flow-centric approach, to protect fish and wildlife beneficial uses. This analysis is manifestly unreasonable because it does not provide an analysis of the "reasonable alternatives" to a flow objective, or even any criteria against which to measure the effectiveness of flow objective alternatives. (23 C.C.R. § 3777, subd. (b)(3); *City of Maywood, supra,* 208 Cal.App.4th at p. 420.) "Reasonable alternatives" to the flow objective are any alternatives that could accomplish most of the basic goals of the amendments to the water quality control plan. (CEQA Guidelines, § 15126.6(c).) In reviewing and amending a water quality control plan, the State Water Board's fundamental goal and statutory mandate is to establish water quality objectives that in its judgment will ensure the "reasonable protection of beneficial uses . . .." (Wat. Code, § 13241.) Thus, in seeking to establish water quality objectives that will ensure the reasonable protection of fish and wildlife beneficial uses, the State Water Board must take a broad view, and consider a variety of factors, including the environmental characteristics and quality of the waters under consideration. (*Ibid*.) To achieve the basic goal of providing for the reasonable protection of fish and wildlife beneficial uses, the State Water Board should consider the various water quality characteristics or constituents that affect such beneficial uses and establish reasonable water quality objectives for those characteristics or constituents. Because the SED's statement of objectives is skewed, the SED fails to analyze reasonable alternatives to the proposed action that could feasibly accomplish the basic goal of providing for reasonable protection of fish and wildlife beneficial uses, and which could avoid or substantially lessen the significant effects of flow objective alternatives. The range of alternatives needs to be expanded to include an analysis of non-flow alternatives that could provide for the reasonable protection of fish and wildlife beneficial uses.

3. The SED Fails To Analyze Reasonable Alternatives To "Mimicking The Natural Hydrograph" Or To The "Unimpaired Flow" Regime

The SED evaluates four "alternatives" for LSJR flows during the February-June time frame, including the No Project Alternative (LSJR Alternative 1) and three other LSJR Alternatives (LSJR Alternatives 2, 3, 4). (SED, at p. ES-14.) However, LSJR Alternatives 2, 3, and 4 all contain the same narrative objective and only differ in terms of the percentage of unimpaired flow specified in the program of implementation for each of the "alternatives." The SED states that these unimpaired flows provide a "range" allows for the evaluation of alternatives that would attain the project's objective of providing inflows while also reducing any significant effects of the project." (SED, at p. ES-14.) However, the SED fails to analyze other, reasonable alternatives that do not use the "unimpaired flows" approach. By limiting the alternatives analyzed to percentages of "unimpaired flow" the SED constrains the State Water Board's ability to evaluate whether there are alternative flow regime approaches that could potentially reduce the significant impacts associated with the various unimpaired flow alternatives. Alternative approaches could include, for example, approaches that examine the essential physical and ecological processes necessary to support native fish populations and the actions necessary to provide those processes.

There are at least two alternatives to percent-unimpaired-flow that warrant consideration, particularly since they were identified by Delta Independent Science Board ("ISB") (Oral Comments, 12-Jan-2017): statistical approaches and the "functional flow" approach. The Delta ISB requested the State Water Board staff write sections and include them in the Draft Revised SED evaluating these two approaches.

Statistical Approaches:

Statistical approaches could use several lines of analysis to address instream flow and other needed management actions. There are numerous studies that evaluate the relationship between flow and particular fish population parameters. These studies could be summarized in each area of interest including the three east-side salmon-bearing tributaries of the SJR and the SJR mainstem. Flow recommendations could be provided from these approaches for each species and life stage in all of the areas of interest for which information exists. Data gaps could be identified and special studies could be specified by State Water Board that are needed to complete the update for the LSJR alternatives.

Another potential statistical approach that has been used in the Central Valley of California is Ecosystem Diagnosis and Treatment (EDT; ICF International, Portland, OR). EDT has been applied in the SJR already (SJRRP 2010; ICF International 2014). The habitat from Friant Dam to the SJR confluence with the Merced River has been explicitly modeled. The river segments downstream have been modeled with multipliers from the Merced River to Vernalis. The Delta and the ocean modules have also been modeled to get adult return predictions for Chinook salmon for the Reach 2B alternatives for the San Joaquin River Restoration Program (*Ibid*.). The SJR habitat segments from the Merced River to Vernalis could quickly and easily be modeled. Furthermore, EDT could be applied in each of the three east-side salmon-bearing tributaries of the SJR. The results from EDT provide a ranked set of restoration priorities and limiting factors that are most likely to recover salmonid populations, e.g. improve temperature conditions in a particular reach in a specified time period. In addition, EDT will rank flow parameters for each life stage; this ranking would be for those flow parameters that could be changed to recover salmonid populations. Thus, EDT provides a framework to rank the most important restoration actions for salmon recovery: riparian improvements, connectivity improvements (e.g. floodplain connection), channel stabilization, temperature parameters (e.g. coldwater dam releases), changes in predation (e.g. predator removals), and flow parameters. Furthermore, EDT does this for every life stage and species of interest. Because EDT has been applied on San Joaquin River (ICF International 2014) and could be quickly adapted to all of the SJR and the three east-side tributaries and because of its successful use in Butte Creek (Butte County, CA), EDT seems a vital modeling framework to apply as an alternative to the unimpaired flow approach.

The third statistical approach that could be considered is the Indicators of Hydrological Alteration (IHA) approach (Richter et al. 1996). IHA statistical methodology could be applied to three east-side salmon-bearing tributaries of the SJR and the SJR mainstem. IHA would identify which of 33 metrics of flow alteration are the most severe for each area of interest. Then, these results could be used to fine tune how a new flow prescription could be specified.

Functional Flows:

Yarnell, et al. (2015) recently elaborated the functional flow approach. They suggested that rather than trying to mimic the historic natural flow regime that specific components of the natural flow regime be identified and retained. These components directly relate to process-based parts of the flow regime and some of their examples include: "wet-season initiation discharges, peak magnitude flows, recession flows, dry-season low flows, an interannual variability."

The functional flows approach was used successfully on the Yuba River (HDR 2007). The Yuba Accord was a collaborative process representing most of the fisheries agencies, water users, and other agencies and took place over a period of approximately two and a half years (*Ibid.).* A The Yuba River technical team developed these discharge schedules without consideration of existing regulatory requirements or historic requirements. This allowed development of a new set

of flow schedules based on a Stressor Matrix, scientific considerations, basic operational constraints, and hydrologic probabilities.

While the State Water Board provides no analytical methods for determining the flow schedule that will be prescribed across February through June, functional flows analysis is a rich area of study and example approaches can be drawn from many recent studies. Various approaches have been used to develop relationships between flow characteristics and biological response. Examples include use of habitat suitability models that relate flow change to requisite habitats for target taxa (e.g., MesoHABSIM, Parasiewicz et al. 2013; and PHABSIM, Beecher et al. 2010); establishment of functional flow regimes to support species of management concern (McClain et al. 2014, Yarnell et al. 2015); and use of statistical ranges of sustainability based on unaltered hydrographs (Richter et al. 2011).

ELOHA Approach

One such method that brings together concepts from several of these approaches is entitled the Ecological Limits of Hydrologic Alteration (ELOHA) framework (Poff et al. 2010; https://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/ELOHA/Pages/ecological-limits-hydrolo.aspx). The ELOHA framework uses a variety of hydrologic and biologic tools to determine and implement environmental flows at the regional scale. Results of the ELOHA analysis can inform management decisions, such as release rates from dams, reservoirs or basins, diversion volumes for irrigation or water re-use, or flows associated with stream restoration. Because the ELOHA framework provides a way to assess the effect of flow alteration on the condition of biological communities (vs. individual taxa) on a regional basis, it is a useful approach for setting targets across a wide range of geographies and stream types where comprehensive detailed site-specific investigations are not practical.

FDA Approach

The field of functional data analysis (FDA) is a growing area of statistical research that provides an alternative way forward for river ecologists and managers looking for methods to address questions of flow ecology (Stewart-Koster et al. 2014). The FDA approach uses functional linear models to capture the entire hydrograph as a predictor variable to identify relationships between single observations of fish abundances and river flow over the course of a year (Stewart-Koster et al. 2014). This solves the problems of selecting a subset of flow metrics and quantifies a direct link between fish in the stream and the river flow they experienced. The models can provide managers with a specific understanding of the timing, magnitude and duration of ecologically important flow events to replicate when setting environmental flow standards. In addition, functional models may provide a valuable tool for ecologists seeking to explore the flow–ecology relationships of poorly understood species.

The State Water Board seems to imply that the unimpaired flow approach is the only solution, thereby ignoring the numerous flow prescription approaches already described in the literature and successfully applied throughout the world. (See Section 19.1.2). For example, a major reference that the State Water Board relies on to support a more natural flow regime, and ultimately to support its unimpaired flow approach, actually implemented a functional flows approach to develop a flow regime. The flow regime implemented in Putah Creek, CA, as described by Kiernan et al. (2012) and referenced by the State Water Board on page 19-5 of Chapter 19, was developed using a functional flows approach (described as ecosystem-based flows by Moyle et al. 1998). Kiernan et al. (2012) and Moyle et al. (1998) describes the approach that the Putah Creek Accord took to achieve a more natural flow regime, specifically by mandating functional flow measures, including pulse flows to attract and support anadromous fishes and

reduce numbers of exotic species not adapted to extreme flow events, baseline flows to maintain spawning and rearing habitat, and drought flow requirements to ensure permanent stream flow during dry years. However, the State Water Board does not acknowledge the approach taken in Putah Creek to achieve more a more natural flow regime, erroneously citing the Putah Creek project as support for their unimpaired flows approach.

Similar to Putah Creek, the State Water Board cites multiple papers from Dr. LeRoy Poff of the Colorado State University Stream Ecology Lab to support a more natural flow regime, (SED, at p. 19-7 and 19-8), however, the incorporation of these papers fails to draw on the actual approach developed by Poff et al. (2010) to inform the development of environmental flows. The Poff et al. (2010) paper that the State Water Board cites presents a consensus view from a group of international scientists on a new framework for determining environmental flow needs on a regional scale. The framework that Poff et al. (2010) describes, called the ecological limits of hydrologic alteration (ELOHA), is a well-crafted synthesis of environmental flow methods that provides scientists, water-resource managers and stakeholders with a detailed approach to analyze and synthesize available scientific information into ecologically based and socially acceptable goals and standards for management of environmental flows. This approach is not only detailed in Poff et al. (2010) but example applications are available throughout literature, including a recent application in the San Diego River watershed (Stein et al. 2016), the Upper Tennessee River (McManamay et al. 2013), a Mediterranean river basin (Solans and Garcia de Jalon 2016), and Australian river systems (Swirepik et al. 2015). Instead of specifically drawing from this fully developed approach for prescribing environmental flows, the State Water Board fails to mention the recommended approach of Poff et al. (2010) and others, instead the SED uses the literature to support their approach of unimpaired flows.

The SED fails to serve its fundamental purpose as an informational document for the decision makers as well as the public, because it offers no evaluation of alternatives for how to get the most good from use of the limited water available. Carryover storage in reservoirs will obviously be affected in many years and there is no consideration of how that should affect choice of amounts and duration of flow prescriptions. The tradeoffs to fish of spreading the use of water across 5 months rather than focusing on specific functions are not discussed. Use of a salmon lifecycle model and/or other analytical tools is needed to assess the relative contribution of various elements of the proposed management strategies and the associated predictions of biological benefits to the population dynamics of the target species. For example, rather than providing higher sustained flows over extended periods during the February-March period for fry migration the application of short-duration pulse flow migration cues may be a more effective management strategy. Results of these comparative analyses would be useful in identifying substantial differences in management strategies that impacts how water operations could support productive salmon runs.

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(SLDMWA & WWD March 17, 2017 COMMENT LETTER)

ATTACHMENT

980 NINTH STREET, SUITE 1500
SACRAMENTO, CALIFORNIA 95814
HTTP://DELTACOUNCIL.CA.GOV
(916) 445-5511

Delta Independent Science Board

To: Mr. Les Grober, Deputy Director, Division of Water Rights
State Water Resources Control Board

From: Delta Independent Science Board

Re: Review of SWRCB's "Working Draft Scientific Basis Report for New and Revised Flow Requirements on the Sacramento River and Tributaries, Eastside Tributaries to the Delta, Delta Outflow, and Interior Delta Operations"

Summary

Insightful, informative, well-illustrated, clearly written—these are among our overall impressions of "Working Draft Scientific Basis Report for New and Revised Flow Requirements on the Sacramento River and Tributaries, Eastside Tributaries to the Delta, Delta Outflow, and Interior Delta Operations". The comments below focus on recommended improvements.

In particular, we recommend clarifying, and further justifying scientifically, the proposed use of percent of "unimpaired flow" as the main basis for establishing an annual environmental water budget. We also suggest presenting a further review of cold-water management, a deeper analysis of non-flow stressors, additional consideration of near-term responses to climate change, and elaboration of how regulations managed adaptively may improve scientific understanding of environmental flows.

Introduction

Staff of the State Water Resources Control Board asked us on October 13, 2016, to review the SWRCB's "Working Draft Scientific Basis Report for New and Revised Flow Requirements on the Sacramento River and Tributaries, Eastside Tributaries to the Delta, Delta Outflow, and Interior Delta Operations" (draft of October 16, 2016). The staff described this draft report as proposing a science basis for eventual policy decisions that would balance water management policies across management objectives. The staff provided questions that guided our review, and also provided paper copies of the report.

The draft report begins by describing its purpose and structure, and by summarizing much of its content (Chapter 1). Next it presents, stream by stream, differences between present-day flows and unimpaired flows, chiefly in the Sacramento Valley (Chapter 2). The draft report then quantifies relationships between freshwater flows and the abundance and distribution of selected species of fish and

invertebrates in the Delta and in other parts of the San Francisco Bay estuary (Chapter 3). In a mainly qualitative way, the report also considers stressors other than reduced freshwater flows (Chapter 4). Finally, these various findings are brought together to support recommendations on environmental flows (Chapter 5). Comprehensive reference lists follow (as Chapter 6).

The SWRCB is commended for developing the in-house expertise that this draft report reflects. The draft provides an insightful, informative, highly readable compendium and analysis of existing scientific understanding of how the populations of certain native species, chiefly fish, are likely related to freshwater flows. It also acknowledges stressors other than low freshwater flows and considers in a brief but appropriate fashion how these stressors can interact with flows.

We recommend strengthening the draft's treatment of unimpaired flow, cold-water management, non-flow stressors, climate change, and adaptive management. We also offer additional suggestions on content and presentation.

Recommendations

1. Clarify the use of annual volumes in the "unimpaired flows" approach

The report could build on the explanations in sections 5.1 and 5.2 to describe more clearly the "unimpaired flow" approach and to explain how this approach would be implemented.

In our understanding, the proposed approach would establish a fixed annual volume of water to be used for environmental purposes, while also yielding flows that resemble natural flows in "frequency, timing, magnitude, and duration" (p. 5-3). The fixed annual volume of water would ideally provide environmental managers with a tool to operate in cooperation with other basin interests for more effective, flexible, and adaptable ecosystem management. The quantity of this environmental water budget would be based on a fixed annual percentage of unimpaired flow on each tributary or for the basin to operation for environmental purposes. If cooperative basin operations are not negotiated successfully, then the annual unimpaired flow volume would be operated under state authority.

It would be useful for the report to separately clarify a) how the fixed annual quantity of water would be used, with and without successful agreements among basin water managers and b) how the annual water volumes would be calculated (by basin and/or by tributary). The "unimpaired flows" label seems to better describe the basis for annual volume calculation, rather than the perhaps more ecologically important issue of how the volume would be managed.

2. Compare the SWRCB approach with alternatives

The report could be improved by adding a comparison of the "unimpaired flows" approach with other science-based approaches to establishing flow requirements for fish and aquatic ecosystems. Examples of other approaches can be found in reports by Adams, Arthington, Bunn, Linnansaari, Poff, Richter, Tharme, and Yarnell (full citations are provided in our reference list). Three alternative approaches are briefly reviewed below, after comments on the "unimpaired flows" strategy.

The recommended comparisons could evaluate approaches in terms of scientific merit, ability to respond to extreme events and climate change, ability to accommodate other water management objectives (water supply, flood management, etc.), and alignment with regulatory objectives.

The comparisons may show how the proposed environmental water-budget approach can combine the best aspects of other scientific approaches for establishing environmental flows. A hybrid approach, which often has value (Kiernan et al. 2012), could allow for more effective and adaptable environmental flows, and these could have less impact on other water users than would a single, less flexible approach.

Unimpaired flows. The proposed unimpaired flow basis for environmental flows is relatively easy to administer and should support flexibility in working with regional interests and different regulatory needs, water projects, and water users to implement diverse operational and management activities to benefit native species and human water users. Establishing the size of an annual environmental water budget as a fraction of unimpaired flows would result in flows that largely depend on each year's precipitation. A consistent technical method for quantifying the unimpaired flow for different years will be needed, such as the proposed Sacramento Valley Unimpaired Flow Model (SVUFM). This unimpaired approach roughly approximates natural annual flow variability. Quantifying the environmental water budget this way has relatively few complications and is relatively fast to implement. Moreover, it seems to allow considerable flexibility in working with regional interests for the benefit of both native species and human water users. Flexibility in its implementation might be its greatest advantage.

An unimpaired flow approach for quantifying annual environmental flow assets could still be controversial, but it would add quantification to decision making and discussions about its appropriate use. Field data from river mouths and tributaries are often limited, and this limitation can lead to heavy reliance on modeling. A program of monitoring and modeling, in which models are frequently tested and updated, will be needed to support quantification of unimpaired flows. Because each year's operations will need a forecast estimate of unimpaired flow, some basis for correction of carryover of unused environmental water should be considered. Any modeling and monitoring framework used as a regulatory assessment tool for reckoning flow in junctions, river mouths and smaller tributaries should be tested thoroughly with field data and modified as needed to improve efficacy and reliability. Like many other entities, the SWRCB will need additional monitoring to support adaptive-management activities in the Delta.

Natural flows. The draft report recognizes that native biota and ecosystems evolved with natural flows over millennia (the "natural flow doctrine"); flows more nearly natural than those of recent decades should be favorable for restoring native species and ecosystems. Section 3.2.1 notes, for instance, that emulation of natural flows helped native fish regain dominance along lower Putah Creek (Kiernan et al. 2012). The report further recognizes that natural flows are difficult to produce in today's altered Delta, with its diminished and disrupted habitats (especially lost floodplains), non-native species, and pollutants. The report also briefly identifies climate change as likely to lead to further departures from the natural conditions that prevailed in the centuries before the mid-19th century Gold Rush (sec. 4.6).

The report could elaborate on how and why unimpaired flows differ substantially from natural flows in parts of the Central Valley where loss of floodplains and wetlands has been extensive (DWR 2016; Fox

et al. 2015). These differences could be considered where the SWRCB or others are recommending habitat expansion or improvement, invasive species management, and/or contaminant management to enhance the native food web. Of course we do not recommend attempts to precisely re-create natural flows for the Delta, but modeling natural flows may be informative, even though pre-development conditions and natural flows are difficult to simulate accurately.

Statistical correlations. Regression and other statistical analyses can be insightful where data on flows and fish can be correlated (Linnansaari, et al. 2012). Examples in the SWRCB report show that populations of many native and non-native species are correlated with streamflows in, around, and out of the Delta. Indeed, many native species appear to benefit from additional streamflows at some times and locations, either directly or from additional habitat that comes from greater inundations. Correlations do not always indicate clear causation. The SWRCB report nicely explains many of the broad statistical relationships.

Nevertheless, regressions from past data may not be predictive into the uncertain future, especially in the face of 'regime' changes like the pelagic organism decline and the consequences of climate change. Fundamental ecological relationships between newer fish assemblages and changes in chemical discharges and runoff will affect future statistical relationships, as will changes in water temperature. Also, some correlations are spurious, and some statistical analyses have led policies astray.

The draft report could briefly discuss the relative value of statistical approaches and how to address their weaknesses over the long term, particularly in the implementation of the proposed SWRCB approach.

Functional flows. Functional flows are a mechanistic approach for estimating flow needs and trade-offs (Yarnell et al. 2015; DISB 2015). Flows needed are based on field observations of life stages and computer and conceptual models of hydrodynamics, habitat, and ecological conditions for different flows. Environmental flows are then chosen to support different ecological functions and life stages of selected species. The report acknowledges this approach in many aspects of its discussions and organization (such as in section 3.3 and 3.4.1).

The advantage of a mechanistic approach is its greater ability to explain cause-effect and to lead to new knowledge (via adaptive management). The disadvantage of this approach is the requirement for long-term organization, funding, modeling, and research. In this sense, it would not be possible in the near term to base effective environmental flows exclusively on functional flows. Mechanistic modeling has been developed for other major aquatic systems (DISB 2015), but not for California's inland fishes. Over time it is desirable for ecosystem management to increasingly employ more of a functional flows approach, which can better adapt to changes in conditions and scientific understanding and better integrate management of flow and non-flow stressors, as has been seen for floodplain restoration (Sommer et al. 2001; Ahearn et al. 2006).

In comparing scientific bases for establishing environmental flows, the report could discuss how this approach might fit in implementation of the SWRCB approach in the near term and in the long run, as well as the scientific advances that would be needed to apply a functional flows approach in individual river basins or system-wide. This should include some discussion of the experimental aspects of environmental flow operations in an adaptive management context.

3. Include more emphasis on managing water temperature

The draft report briefly introduces the importance of water temperature for aquatic organisms (sec. 4.3.4) and contains a major section on management of cold-water pools downstream from reservoirs (sec. 5.4). We agree that water temperature strongly controls fish physiology and survival and that temperature cues are important for specific life history phases and migrations. Temperatures also affect a range of chemical and other biological processes that affect aquatic ecosystems in many ways.

The report could expand on this important stressor. Potential amendments include:

- Further efforts to assimilate and synthesize available data on flow-temperature-fish relationships, and on how such information should be considered in management.
- Further evaluation of temperatures expected from a warming climate (beyond those cited in sec. 5.4.1).
- References to each agency's ongoing temperature data collection, modeling, and monitoring efforts for major rivers tributary to the Delta. These could be useful and informative for basin discussions and overall regional and state coordination.
- Recommendations for research in support of managing temperature in real time and seasonally.

4. Include more examination of non-flow stressors

Chapter 4 of the draft report acknowledges many non-flow stressors and identifies them as having contributed to species declines. It considers interactions that enable the effects of non-flow stressors to exacerbate the effects of low flows, and vice versa. These interactions show that greater scientific understanding of non-flow stressors could provide a better basis for negotiated agreements among responsible agencies, as sought by SWRCB.

The report could do more in assessing the contributions of non-flow stressors to declines in native fish and wildlife in the Delta and estuary. For example, quantitative assessments have been made for effects of pesticides on salmonids (Baldwin et al. 2009), and fish abundances could be graphed against non-flow stressors (with suitable caveats about the pitfalls of statistical correlations).

The report could also provide more information about direct and indirect stress from non-native aquatic plants. Their effects include increasing water clarity (to the likely detriment of Delta smelt) and reducing sunlight penetration and flows in some areas (as shown by recent studies of Boyer et al.). Conversely, flows have direct and indirect effects on the extent and timing of alien-plant invasions and residence times of contaminants and nutrients. Section 4.4.3 describes control efforts for non-native vegetation, but it would be helpful to indicate efforts to reduce the impacts of non-flow stressors and interactions with flows and climate change.

5. Pay additional attention to climate change

Climate change is identified as a stressor that affects fish and wildlife via water supply reliability, flooding, salinity intrusions and temperature (p. 4-16). Hydrologic conditions, particularly unimpaired flow and stream temperatures, are also expected to respond to climate change. Despite uncertainties in the quantitative effects of climate change, we suggest adding literature on the effects of climate change on hydrologic conditions in the Delta, (e.g., Cayan et al. 2010; Cloern et al. 2011; Stern et al. 2016). Even if changes in climate are modest in the near future, the report should consider longer-term changes because: (1) Substantial responses needed to sustain native ecosystems with climate change are likely to

require near-term actions, such as land acquisition to prepare tidal marshes and habitats for higher sea levels. (2) To manage for maintaining coldwater conditions, planning to change water-temperature controls from dams and other infrastructure changes to manage rising temperatures might require consideration decades in advance. (3) Data collection in the near term could better prepare ecosystem managers for changes in climate mixed with the other expected changes. (4) Longer-term adaptability, particularly in implementing regulations, will require strategic changes in regulatory philosophy and methods. At this stage, regulatory responses would be anticipatory, but could still be substantial. (5) The flow plan under development suggests maintaining 'current' flows within 35% - 75% of the unimpaired flows, and it acknowledges the long-term variability of unimpaired flow (Gleick and Chalecki 1999). Discussion in this report could extend beyond the current focus on year-to-year variability and include multi-year variability and climate cycles.

6. More on Adaptive Management

Both management and regulations will benefit from adaptive, science-based approaches. Flow regulations will continue to evolve as the Sacramento-San Joaquin Delta changes and new scientific understanding emerges.

The revised report could examine how adaptive management could dovetail with the new flow regulations and approach proposed (DISB 2016). This discussion could include speculations on a long-term science and technical program (including modeling and experimental approaches to setting flows) to support the SWRCB's long-term interests in the effectiveness of environmental flow regulations, which should be done in conjunction with other agencies having related interests. A common scientific and technical program would have obvious benefits for supporting traditional regulations, and even more benefits for the SWRCB proposals to implement regulations through broad basin agreements involving many parties, likely including various state agencies. Agreements become more difficult to negotiate, implement, enforce, and improve without a common scientific and technical basis. The same holds true for adaptive management; we recommend a sustained scientific and technical program for adaptive management, in concert with other agencies.

We thus suggest that SWRCB should consider developing a scientific program to address scientific and technical issues that are likely to arise while implementing this round of regulatory changes and the development of more flexible operating standards, in concert with stakeholders and other agencies. The report would also benefit from a discussion of how the organization of monitoring and research might improve regulatory decisions into the future.

Other suggestions

Content:

Add new science on vegetation. Because vascular plant growth and distributions are related to hydroperiod and salinity (Boyer and Sutula 2015), the Delta's existing wetlands will respond to increased environmental flows. The habitats include shallow waters dominated by submersed aquatic plants (Boyer et al. 2012, 2015) and habitats dominated by emergent plants. Increased flows could result in greater plant growth, which might be considered positive for the regional ecosystem, because vascular plants contribute to the base of the food web and structure habitats for aquatic invertebrates (Boyer et al.

2013, 2016). On the other hand, potential negative effects of increased flows could include increased growth of existing and future invasive plants (Boyer and Sutula 2015).

Consider setting inundation-duration periods in standards for floodplains. This approach may be useful in Yolo Bypass or the northeastern Delta. Different parts of streams might need different flow characteristics. Floodplains seem to have a disproportionate role in sustaining native fish species. Rip-rapped edges might need different flow velocities than vegetated streams or streams with overabundant floating or submerged vegetation. (Sommer et al. 2001, 2004; Ahern et al. 2006)

Address sediment flows. Water flows, especially floods, have a major role in mobilizing and transporting sediment and associated materials (e.g., particulate organic carbon).

Consider suppressing undesirable species by managing flows. Native species might benefit from this approach.

Balance species and economics. While most native species tend to cluster in areas with the more natural flows, the most popular non-native recreational fish (striped bass, *Morone saxatilis*) has somewhat different flow preferences. Could the SWRCB report present science-based trade-offs? Similarly, are there trade-offs between environmental benefits and economic benefits of water uses (for cities, agriculture, and recreation) that might have a science base? Or will economic and other socially-desired flows be addressed in other reports or impact statements?

Elaborate on coordination with other entities. Many state, local, and federal agencies share concerns expressed in this report and have substantial scientific expertise and policy responsibilities for the maintenance and management of ecosystems in the Delta estuary and upstream. Effective coordination among SWRCB and other agencies is warranted for compiling and synthesizing the science that informs flow regulating in the Delta for the common purposes of state, local, and federal agencies.

Presentation:

Add or improve graphics and tables. Add a diagram early to show how this Scientific Basis report fits into the larger scheme of SWRCB reports and regulations. Readers would benefit from seeing coverage and issues in this broader context. The diagram could show how each report is intended to support the process of establishing environmental flows and their implementation and updating.

Add a summary table. Add a summary table identifying and summarizing Delta flow and export limits as they exist today and as they might change with the proposed approach; this would be useful in the last chapter.

Add selected graphics. Amend Fig. 3.13-1 to explore potential cause and effect. Declines could be compared by stacking each species graph above a time series of flow parameters. On each flow graph, the "protective" ranges in Table 3.13-2 could be highlighted to support how "many of the native fish and wildlife species maintained healthy populations until the past several decades when water development intensified" (p. 1-3, and p. 5-2). Graph the contrast on page 1-13 between a wet 2011 and a dry 2012–2015 as "a dramatic example of the importance of flow for native fish species." Add graphs on the effects of the invasive clam *Corbula* on pages 3-7, 3-11, and 4-13. Show stressors and outcomes against

time, for referencing dates of key efforts to improve outcomes, such as “implementation of D-1641” (p. 1-13).

Add a small table covering each stream. Comparable summary statistics for each stream, and information such as mean annual flow, lowest flow, major hydrograph components, species composition, major reservoirs or blockages, diversions, and existing flow requirements would be a welcome addition. Some better location and descriptive maps would also help.

Forewarn that different geographic ranges will be used. Chapter 1 begins with “Sacramento River watershed and related areas” (p. 1-1) which could be clarified in a map that plots the geographic ranges considered in Chapters 2 and 3. The hydrology in Chapter 2 covers the watershed north and east of the Delta, and also considers the Delta itself and the Suisun “region.” The “related areas” include migratory ranges that extend into the Pacific Ocean (salmon, p. 3-3) and San Pablo Bay (Longfin Smelt, p. 3-8). Species considered in detail (section 3.3) include many that depend on the estuary (p. 3-10). The “related areas” in the context of loss of tidal wetland, as a stressor, appears to exclude estuarine areas seaward of Suisun Bay (p. 4-2).

Consolidate references. Users of paper copies will struggle to find references cited among the lists that are specific to chapter or section.

Add a record of track changes. If this is a living document, include a tabular summary of changes to flow requirements and their scientific basis.

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