To: Jeanine Townsend, Clerk of the Board
State Water Resources Control Board
1001 I Street, 24th floor
Sacramento, CA 95814-0100

From: Dr. Steven White, Professor Emeritus
Dept. of Biological Sciences, Duncan Hall Rm240
San Jose State University
San Jose, CA 95192
steven.white@sjsu.edu

I am writing in support of a minimum 40% (ideally 50%) unimpaired river flow for the Merced, Tuolumne, Stanislaus and San Joaquin river network. Since the Flow Criteria Plan for the San Joaquin-Sacramento Delta Ecosystem (1) itself recommends an unimpaired flow of 60% (February through June) as necessary to provide for recovery of the river ecosystem to a level sufficient to support wildlife (especially the salmon populations) and the associated riparian habitats, arguing for 50% unimpaired flow hardly seems illogical. There are many reasons for supporting a 50% unimpaired flow level, some of which I wish to briefly present.

First, the Bay-Delta (despite it's profound alteration over the last 150 years) forms the largest remaining estuary on the west coast of the Americas, providing critical habitat for well over 500 different species of wildlife, serves as a major migration pathway for salmon, steelhead and sturgeon moving between the Pacific ocean and their home/spawning streams along the Sierra, as well as acting as a major stop along the Pacific flyway. It is profoundly important ecologically, as well as providing valuable economic, social/cultural and recreational benefits. The health of this critical ecosystem is vitally important and its recovery must be continued.

Unfortunately, the reduced flows that have operated throughout the Delta and its associated input river networks over the past 15-20 years have taken tremendous tolls on the health of this complex ecosystem. On average less than 50% of the aggregate freshwater flow from the San Joaquin river network ever reaches the Bay, and in some years less than 35%. This reduced freshwater inflow shifts the shape, size and location of the salinity mixing zone within the Delta, ultimately affecting everything in the food chain from plankton to marine mammals (2). And this detrimental mixing zone shift is now a chronic feature of the Bay-Delta system, accruing incremental biological/ecological damage over time as native species (from bacteria to invertebrates to fish and plant life) are out-competed by invasive ones better suited to the altered salinity zones now present in the Bay-Delta system. In some cases it is not simply a matter of competition but outright toxicity, as evidenced by the observation that reduced freshwater inflows have so modified the water chemistry of the Delta that cyanobacteria can thrive, producing neurotoxins that can sicken or kill a whole range of species (from beneficial plankton to animals up to and including humans) (3).

These detrimental effects on the Bay-Delta region as a result of low flows, however, are exacerbated by even greater flow restrictions in the three major tributary rivers feeding the San Joaquin. Between 1986 and 2009, for example, from 60% to nearly 80% of the February to June unimpaired flow was diverted for agricultural, urban and/or industrial use which, in the case of the Tuolumne river allowed only 21% of the water to flow downstream [4].

TABLE I. MEDIAN PERCENTAGE OF UNIMPAIRED FLOW IN THE LOWER SAN JOAQUIN RIVER TRIBUTARIES

Tributary	Median February to June Percentage of Unimpaired Flow (1986-2009)
Stanislaus River	40%
Tuolumne River	21%
Merced River	26%

Data Source: State Water Resources Control Board, Bay-Delta Water Quality Control Plan Draft Substitute Environmental Document (2012).

Predictably, these severe flow restrictions helped generate disastrous effects upon the river ecosystems. The resultant impediments to fish migration, reduction in access and/or availability of floodplain habitat (important to many juvenile fish in foraging and protection from predators), reduction in spawning sites, the raise in water temperatures, decrease in river current and aeration, decrease in dissolved oxygen, concentration of pollutants (pesticides, herbicides, fertilizer components, industrial pollutants etc) as a consequence of the reduced water volume, altered migratory cues to fish etc were certainly part of the well documented decimation of the salmon populations that historically utilized those rivers [5]. And the salmon are a "keystone species", also (at various stages of the salmon's life cycle) providing food for other animals and important in the net transport of nutrients from the ocean to upland habitats. The reduced flows imposed upon these rivers have imperiled not just the commercial salmon fishing industry [6], but the ecological balance and health of the very rivers themselves.

That said, certainly the agricultural sector in the San Joaquin valley and associated watershed needs and deserves use of some of the water that is the lifeblood of the San Joaquin river network and a key component of the Bay-Delta ecosystem. What must be reasoned out is what level and types of agriculture are sustainable, given the finite amounts of water present and the simultaneous necessity of sustaining healthy river ecosystems. The extent of agriculture, it's predominant crop types and it's practice and technology have changed greatly over the last 100 years, and especially so since the mid-to-late 1800's when water rights were first starting to be established across much of the Central Valley (7). As agriculture changed (both with respect to the type of crop grown, the availability of

tractors, harvesters, combines and the like, the development of powerful and efficient pump technologies etc) more and more land was irrigated [8] and the demand for water expanded accordingly. By the early-to-mid 1900's groundwater pumping for irrigation had become so excessive that dramatic and damaging land subsidence was occurring throughout most of the Central Valley… but agriculture continued to expand. The federal Raker Act (1913) permitted the first serious round of dam constructions in California, but that too was insufficient. The resultant demand for water by the agricultural sector drove the formation of the California Water Project (1933) and the damming of most of the major rivers draining from the Sierra mountain range. These actions allowed a degree of river flow reduction and diversion to agricultural use that has now become incompatible with continued viability of the San Joaquin river system network.

In the last 150 years humans have so greatly modified this planet that its health… its ecosystem quality and stability… teeters as if on the edge of a knife. We've destroyed great forests across the globe and continue to decimate what remains at the alarming rate of thousands of acres *a day* worldwide. We have drained dry great lakes (Tulare Lake in California… the largest lake west of the Mississippi and one we drained dry by the middle of the last century… is one ignominious example) and *entire seas* (the Aral Sea disaster is our shameful example) to feed agriculture's insatiable thirst, while submerging our most beautiful canyon systems (Hetch Hetchy valley and Glenn Canyon systems, for example) to supply our continued and unsustainable urban development. We must take a different route now. As the planet warms we must undertake every effort to preserve in perpetuity those precious, critically important natural ecosystem that sustain us.

Will the urban populations need to conserve water? Absolutely. Fortunately, the Bay Area has already shown it can conserve water consistently over many years. In the Hetch Hetchy service area, for example, water use actually decreased by 30% between 2006 and 2016 as a result of water conservation efforts, even as the population in the area increased. Will urban dwellers need to do a lot more? Without a doubt. The alternative is ruined Bay-Delta environment and dying rivers.

In the 1983 decision "National Audubon Society v. Superior Court (Audubon, 33 Aal.3d 419), the California Supreme Court ruled that California water law is an integration of the public trust doctrine and the appropriate water right system, and that the State had an affirmative duty to take the public trust into account in the planning and allocation of water resources. Beyond this legal requirement, there are moral and philosophical imperatives. Rivers and river ecosystems are in fact a legacy for future generations, and our actions must not jeopardize the quality or viability of this national heritage. So how can we strike a balance in water use that sustains both the agricultural community and the rivers on which all are dependent?

Estimates undertaken by the State Water Resources Control Board indicate that a 40% unimpaired flow through the San Joaquin and its tributaries will result in a small (1.5%) drop in crop revenue as well as a similar decrease (1.5%) in aggregate agricultural economic output and (1.5%) loss in agricultural jobs [9]. If the unimpaired river flow is increased to 60%, crop revenue, agricultural economic output and job loss increase to 4.5%.

TABLE 2. PREDICTED AGRICULTURAL IMPACTS UNDER TWO UNIMPAIRED FLOW STANDARD SCENARIOS

Predicted Impact	40% UIF Standard	60% UIF Standard
Crop Revenue Loss	1.5%	4.5%
Agricultural Economic Output Reduction	1.5%	4.5%
Agricultural Job Loss	1.5%	4.5%

Data Source: State Water Resources Control Board, Bay-Delta Water Quality Control Plan Draft Substitute Environmental Document (2012).

A linear projection between these two estimates thus infers a 3% decrease in all three categories (crop revenue, agricultural economic output and jobs) if the flow through the Stanislaus, Merced, Tuolumne and San Joaquin river complex was targeted to a net 50% unimpaired flow. Leaving, on average, half of a river's water in the river will give it a fighting chance at recovery. Clearly, for ecological purposes the flow rate on any of these rivers on any specific day will probably need to be adjusted (to optimize fish migration and spawning opportunities, to allow for floodplain inundation at the most opportune times etc), but the adoption of a net 50% unimpaired flow provides an adequate framework. Adoption of a net 50% unimpaired flow through this river network will greatly facilitate recovery and health of this vital river ecosystem and, while the 3% or so loss in crop revenues, jobs and aggregate agricultural economic output will undoubtedly be painful, by this approach both the rivers *and* agriculture can survive together, and *both will be sustainable* over the coming decades and centuries.

For all the reasons stated above I respectfully recommend that flow through the Stanislaus, Merced, Tuolumne and San Joaquin river complex be targeted at a net 50% of unimpaired flow. Hopefully and sincerely, Dr. Steven White

References:

(1) "Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem", State Water Resources Control Board, California Environmental Protection Agency. Phil Crader et al. (2010).

(2) Ibid., see also "San Francisco Bay: The Freshwater-Starved Estuary", The Bay Institute. See also "Saving the Lower San Joaquin River and Its Tributaries: The Importance of Instream Flow", National Resources Defense Council, Issue Brief (May 2016).

(3) Berg, M. and Sutula M., "Factors Affecting Growth of Cyanobacteria with Special Emphasis on the Sacramento-San Joaquin Delta", prepared for the

Central Valley Regional Water Quality Control Board, the California Environmental Control Agency and the State Water Resources Control Board, Project Technical Report 869 (Aug. 2015).
(4) State Water Resources Control Board, "Bay-Delta Water Quality Control Plan Draft Substitute Environmental Document (2015), as cited in "Saving the Lower San Joaquin River and Its Tributaries: The Importance of Instream Flow", National Resources Defense Council, Issue Brief (May 2016).
(5) Zeug, S. Sellheim, K. Watry, C. et al, "Response of Juvenile Chinook Salmon to Managed Flow: Lessons Learned from a Population at the Southern Extent of Their Range in North America", *Fisheries Management and Ecology*, vol. 21, no. 155, p155-169 (Apr. 2014). See also Marchetti, M. and Moyle, P., "Effects of Flow Regime on Fish Assemblages in a Regulated California Stream", *Ecological Applications*, vol. 11, no. 2, p530-590 (Apr. 2001).
(6) Grusauskas, M., "California Wild Salmon's Survival Rests on Water Politics", *Monterey County Weekly NOW* (May 2016). See also "Fish Out of Water: How Management in the Bay-Delta Threatens the Future of California's Salmon Fishery", NRDC (July 2008), www.nrde.org/water/conservation/salmon.
(7) Olmstead, A. and Rhode, P. "The Evolution of California Agriculture 1850-2000" in California Agriculture: Dimensions and Issues, ed. By Jerry Siebert, University of California Giannini Foundation of Agricultural Economics, Division of Agriculture and Natural Resources (2003). See also Johnson, R. and Cody, B., "California Agricultural Production and Irrigated Water Use", Congressional Research Service Report 7-5700 (June 2015).
(8) Ibid. See both sources in reference (7) above.
(9) See "Saving the Lower San Joaquin River and Its Tributaries: The Importance of Instream Flow", National Resources Defense Council, Issue Brief (May 2016) and references therein.