SUPPLEMENTAL REPORT OF PROFESSOR G. MATHIAS KONDOLF, PH.D.

I was asked by Natural Resources Defense Council to review the expert reports of Drs. Charles Hanson, Michael Harvey, Rod Wittler, Clair Stalnaker, Don Smith and Joseph Kubitschek regarding the flow and non-flow measures necessary to restore salmon fisheries to good condition in the San Joaquin River below Friant Dam. I address three topics below: (1) uncertainty regarding the impact of a restoration flow schedule on these fisheries, (2) the magnitude of the flow schedule, and (3) non-flow measures necessary to restore these fisheries to good condition.

SUMMARY OF EXPERT OPINION

1. I stand by the conclusion in my earlier report that it is feasible to restore the salmon fisheries in good condition in the lower San Joaquin. I remain confident that the minimum flow releases I have previously recommended, in combination with limited measures to improve fish passage, and time, will create the physical habitat conditions described by Dr. Moyle as necessary to restore and maintain these fisheries in good condition.

2. I disagree with the defendants' experts that a substantial fraction of the natural flow of the San Joaquin River, in combination with a myriad of other non-flow measures, is required to restore fish in good condition in the lower San Joaquin. I furthermore disagree with their opinions that the current level of scientific uncertainty is so high as to preclude the ability to take actions now with confidence that they will restore salmon populations in the near future.

MATERIALS RELIED UPON TO FORM MY OPINION

3. In formulating the opinions stated in this expert report, I have considered the materials specifically identified in this report, and as listed below.

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Richter, B., Baumgartner, J., Wigington, R., and Braun, D. 1997. How much water does a river need? *Freshwater Biology* 37:231-249.

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State Water Resources Control Board (SWRCB). July 2000. Staff Report: Russian River And Other Mid-California Coastal Watersheds: Proposed Actions To Be Taken By The Division Of Water Rights For Environmental Review Of Pending Water Right Applications.

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STATEMENT OF EXPERT OPINION

I. Uncertainty about Impact of Restoration Flow

4. Dr. Wittler, Dr. Stalnaker, Mr. Bender, and Mr. Kubitschek assert that there are so many uncertainties regarding ecosystem response to releasing restoration flows that no flows should be released until further studies have been conducted. Dr. Wittler urges that we "resist the suggestion to immediately implement increased flows" on the San Joaquin, and implies that it took 18 years from the first increased flows to complete the flow study and to synthesize the various studies into a restoration plan. In fact, the actual restoration plan development for the Trinity was accomplished in three years, from 1997-1999. The efforts to develop a restoration plan for the San Joaquin River to date (which were informed by experiences on the Trinity River) have already completed most of the steps outlined on pp.7-8 of Dr. Wittler's report.

5. It is my opinion that there is sufficient information that the hydrograph I have proposed, along with measures to facilitate fish passage at a handful of potential fish passage barriers, will result in restoration of salmon to the San Joaquin.

6. The Stalnaker, Wittler, Bender, and Kubitschek reports merely restate the challenge faced in nearly all ecological restoration, rehabilitation, or similar efforts. Resource managers must deal with uncertainty regarding the causal impact of a flow schedule and other measures which may be undertaken for the benefit of a given fishery. The key question is: is there a reasonable basis for predicting the probable impact of a flow schedule? In my opinion, there is a reasonable basis. If instead restoration required certainty about the outcomes from management interventions, then restoration would always be considered infeasible.

7. While there are certainly uncertainties about the most effective way to restore salmon in the San Joaquin, there is no uncertainty that some minimum flow is necessary for restoration of this fishery, or that the continued drying-up of reaches of the lower San Joaquin will prevent such restoration.

8. While there were certainly numerous pressures on the salmon populations of the San Joaquin in the first half of the twentieth century, there is no uncertainty that dewatering of large stretches of the river channel below Friant Dam was the primary reason for extirpation of salmon below Friant Dam. This was clearly documented by biologists with the California Department of Fish and Game who observed and attempted to prevent the extirpation of salmon (Vestal personal papers).

9. There is a host of reliable scientific information on the life cycle requirements of salmon generally. Similarly, there is reliable information on the number and condition of salmon below Friant Dam in the 1940s, a long hydrologic data record at various locations along the lower San Joaquin, numerous previous studies of actions necessary to restore salmon here, detailed modeling analyses, and field data (current and historical). These data allow us to reduce the uncertainties regarding the requisite actions necessary to restore salmon.

10. There is relatively little uncertainty regarding:

a. the flow of water necessary to create depths suitable for passage of spring run.
b. the ability to maintain adequate temperatures in the first 5 miles below Friant Dam for adult hold and juvenile rearing of spring run.
c. availability of sufficient gravel for self-sustaining populations of salmon to successfully spawn.
d. feasibility of laddering the impediments to upstream fish migration that actually exist; and
e. feasibility of releasing flows from the reservoir in the winter and early spring to allow juveniles to migrate downstream.

11. Drs. Wittler and Stalnaker have pointed out the benefit of conducting studies and modeling analyses before embarking on flow releases for restoration. Fortunately, many

useful modeling analysis, studies and surveys have already been completed by the Bureau of Reclamation, the Friant Water Users, and other responsible agencies. Both Dr. Wittler and Dr. Stalnaker list some of the many reports completed on the San Joaquin River to date, but do not acknowledge that many of the steps they recommend be taken have already been completed, as reported in these documents. Over ninety studies have been conducted on the San Joaquin River since 1992 alone, as listed in Appendix A, compiled by the U.S. Bureau of Reclamation.

12. A plethora of similar studies regarding restoration of salmon has also been completed on other Central Valley tributaries including the Stanislaus, Tuolumne and Merced. Unlike the Trinity case study where managers had to embark on studies in the 1980s with little prior information from comparable rivers, we now have volumes of studies on salmon restoration efforts in the Central Valley dating back to the early 1990s, funded by CVPIA, the 4-Pumps Agreement, the CalFed Bay-Delta program, and other sources.

13. While models are useful tools in planning and designing restoration projects, uncalibrated models are of limited utility. Calibration of models is an important step (as noted by Dr. Wittler on p.7 of his report). To calibrate models of flow, temperature, sediment transport, and channel evolution requires flow in the river channel. The best way to learn, and an essential step to improving models, is to release water and monitor the results. The pilot project to establish riparian vegetation in Reach 2A involved releases of water in 1999 (followed by maintenance flows) and careful monitoring (DeFlitch and Cain 1999). Similarly, a number of studies were undertaken in the 1940s, when fish persisted in the San Joaquin River.

14. Some level of uncertainty is unavoidable in watershed restoration (Anderson et. al. 2003). As noted in the Strategic Plan for the CalFed Bay-Delta Ecosystem Restoration Program (CalFed 1999:10-11): "Additional research can greatly improve our understanding, but it will never erase all of the uncertainty that is inherent in restoring and managing such a large, diverse, complex and variable system." Thus, an adaptive management approach is needed through which we can learn from our implemented actions. Adaptive management does not postpone management actions until "enough information is available." Instead

strategic, incremental actions are implemented to reduce uncertainties and enhance learning (Richter et al. in press).

II. Minimum Flows Require to Restore Salmon

15. In his expert report (p. 27), Dr. Hanson asserted that approximately 60% unimpaired annual flow is necessary to restore spring-run Chinook salmon. I do not understand the basis for Dr. Hanson's opinion that 60% of the annual flow is the absolute minimum flow required to restore salmon to the San Joaquin. I do not find support for his opinion in the references he cites, nor do I find his argument persuasive.

16. Dr. Hanson developed a restoration hydrograph, evidently based on a mixture of methods described in the literature. For the reasons stated below, this hydrograph overstates the amount of water necessary to restore salmon to the San Joaquin River. (This hydrograph would require roughly half of the annual flow, different from the 60% Dr. Hanson called for elsewhere in his report.) While the hydrograph proposed by Dr Hanson might work to support salmon in the San Joaquin River, the hydrograph, and the large volume of water implied, are not necessary to restore salmon to the San Joaquin River. Dr Hanson's assertion that 60% of the annual flow is needed to restore salmon on the San Joaquin River is inconsistent with available evidence, including field observations from the San Joaquin River and neighboring rivers of similar size in the San Joaquin Valley that support salmon.

17. Specifically, for all year types, Dr. Hanson's restoration hydrograph overstates:

a. the magnitude of base flows needed to restore and maintain salmon during the late spring through late winter months,
b. the amount of flows necessary for upstream and downstream salmon migration in February and early March,
c. the volume of water necessary between mid-march and late April necessary to maintain temperature and otherwise support migration of juvenile and adult salmon, and
d. the amount of water necessary to ramp flows down from the spring pulse to the summer base flow.

18. Figure 1 (end) illustrates the excess water for each of these hydrograph components which cumulatively result in restoration flow volumes that on average result in more than 1.7 times more flow then I recommended for salmon restoration in my previous report. Furthermore, since Dr. Hanson's hydrograph lacks a critical year category, his dry year recommendation requires over 3 times more water on average than the critical dry year recommendation I provided in my report. Perhaps the key difference is that Dr. Hanson proposes to restore the San Joaquin River to a largely unimpaired condition, whereas Dr. Moyle and I propose reconciliation, in which we restore anadromous salmon, while still allowing diversions to support other human uses.

Uncertain Basis for Dr. Hanson's Hydrograph

19. Dr. Hanson's explanation of the basis of his hydrograph (pp. 31-34) is difficult to follow. His report described many methods for developing instream flow recommendations, but it did not make clear which (if any) of these methods he actually employed to develop his hydrograph and its various components. Dr. Hanson indicated (p. 27) that numerous studies provided the basis for his assertion that roughly 60% of the annual flow of the San Joaquin is needed to restore salmon, but these studies do not in fact support this assertion.

Misapplication of the RVA Method

20. The Range of Variability Approach (Richter et al. 1997) (RVA) used by Dr. Hanson to develop flow recommendations was never intended for a river like the San Joaquin where a large percentage of the rivers flow is diverted for human use. The third sentence of the summary abstract in Richter et al. (1997:31-32) stated: "The method (RVA) is intended for application on rivers wherein the conservation of native aquatic biodiversity and protection of natural ecosystem functions are primary river management objectives." It further stated: "Application of the RVA will be most appropriate when protection of native riverine biodiversity and natural ecosystem functions are primary management objectives." The RVA was not intended to prescribe a flow schedule for a river in the circumstances of the San Joaquin, where restoring the unimpaired biodiversity and ecological functionality may not be

realistic given the social and economic constraints that require very substantial diversions. The goal here is more limited: creating conditions on the lower San Joaquin sufficient to restore and maintain fish in good condition, as discussed by Dr. Moyle.

21. The restoration hydrograph that I recommended in my previous report, when coupled with limited measures to improve fish passage, will provide flows adequate to meet the habitat conditions required to restore salmon to the San Joaquin, as described by Dr. Moyle. The hydrograph that I recommended will improve riparian habitat conditions for salmon and in doing so benefit other native species, but it will not protect and restore the full range native riverine biodiversity. As I stated in my previous report, "river restoration usually involves restoring specific functions and resources valued by society, not turning back the clock to pre-human disturbance conditions." Furthermore it is possible to restore some riverine resources and functions, while still accommodating human uses such as hydroelectric power generation, irrigation, and/or municipal water supply. A "working river" can support salmon and other fisheries. as illustrated by rivers throughout the Central Valley including the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers which lie immediately north of and are tributary to the San Joaquin. Further, it is feasible to support Chinook salmon and other native fish populations on a fraction of their pre-disturbance flows – far less water than would be specified by Dr. Hanson's use of the RVA analysis.

Incorrect calculation of RVA restoration target values for the San Joaquin

22. Dr. Hanson incorrectly uses the 25th to 75th percentile of unimpaired spring flows to develop flow restoration targets for the spring months. On page 24 of his report, Dr. Hanson states: "Richter et al. (1997) suggest that initial flow management targets be established within the range of the historic mean plus or minus one standard deviation *within the range bounded by the 25th and 75th percentile*" (emphasis added). Dr. Hanson then proceeds to set the spring target flows based on the 25th percentile for dry years, 50th percentile for normal-dry years, greater than the 50th percentile for normal-wet years and the 75th percentile for wet years. However, Richter et al. did not suggest use of the 25th and 75th percentiles for setting flow targets. To the contrary, Richter et al. (1997:236) stated that "the

flow targets must allow some management flexibility to accommodate human uses; selection of values near the interannual mean or median as management targets would entirely preclude human water uses in half of the years."

23. Richter et al. did not specify what the management targets should be, rather that:

> "The Management team must decide on the most appropriate measure of dispersion to use in setting the management targets (e.g. the range, ± 1 or 2 SD from the mean, the twentieth and eightieth percentiles, etc.) and this may vary among the thirty two parameter. The management targets should be based, to the extent possible on available ecological information, and should take into account the ecological consequences of excluding extreme events if that target does not include the full range of natural variation." (Richter et al. 1997:236).

24. Richter et al. (1997:236) did not recommend the 25th to 75th percentile values as default targets, rather that "in the absence of adequate ecological information, we recommend the ± standard deviation values be default for setting initial targets." This standard yields significantly different values than those derived by Dr. Hanson using the 25th – 75th percentile values.

25. In conclusion, Dr. Hanson misapplies the RVA flow target method to the San Joaquin and then misstates the default flow target recommended by Richter et al. for application of the RVA. In doing so, he arrives at inflated spring flow targets that are inconsistent with the default recommendations of Richter et al. (1997) and unnecessary to achieve the objective of restoring salmon fisheries in good condition in the San Joaquin River.

Misapplication of Inappropriate Tennant Method

26. Dr. Hanson apparently relies on the Tennant Method, and a handful of other case studies (discussed below), to arrive at the conclusion that 60%of the unimpaired mean annual flow is necessary to restore spring-run Chinook salmon below Friant Dam.[1] It is my opinion that the Tennant Method is not based on reproducible scientific evidence, is not applicable to the San Joaquin in any event, does not support the conclusion that 60% of the

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[1] Despite this conclusion (p. 27), Dr. Hanson ultimately arrived at flow recommendations that are less than half of the average annual yield for all years.

flow is necessary to restore salmon to the San Joaquin, and does not support the flow regime recommended by Dr. Hanson.

27. Tennant (1976:359) described his method as a "quick, easy method" that was developed from work on streams "north of the Mason Dixon Line between the Atlantic Ocean and the Rocky Mountains." In general, Tennant concluded that 10% of the average flow is necessary to "sustain short-term survival habitat for most aquatic life forms," 30% is recommended to "sustain good survival habitat for most aquatic life forms," and 60% is recommended to provide "excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses." Unfortunately, Tennant (1976) did not provide scientific data to substantiate his method.

28. Even if Tennant's (1976) method was based on sound application of the scientific method, it may not be applicable to the San Joaquin River, since the method was purportedly developed based on observations of streams in a region of the U.S. with very different fish species, climate, and hydrological characteristics. There is no a priori reason to expect that a method developed in such a different region would provide a reasonable basis for establishing flow regimes for anadromous fish in a Mediterranean climate.

SWRCB Bypass Flows for Russian River Tributaries

29. Dr. Hanson references a 1997 staff recommendation of the State Water Resources Control Board (SWRCB) to support his conclusion that 60% of the annual flow is necessary to support salmon on the San Joaquin. It is my opinion that Dr. Hanson has incorrectly described, cited and applied the 1997 staff recommendation and associated peer review study.

30. Dr. Hanson states: "The State Water Resources Control Board Staff recommended that a bypass flow of 60% of the annual average flow on the Russian River be provided to support salmon and steelhead habitat." This is only partially true. Among other things, the State Board was seeking a standard to apply to a large number of applications for permits to divert water from small streams tributary to the Russian River, not the Russian River itself.

31. The 1997 SWRCB staff recommendation was that 60% of the mean annual unimpaired flow be established as the minimum flow between December 15 and March 31 (SWRCB 2000) – not for the whole year. The staff did not recommend that 60 percent of the river's average annual run-off was necessary to support salmon and steelhead habitat, as Dr. Hanson implies. More importantly, the 1997 staff recommendation was not adopted or implemented, due to the results of a peer review process in which I participated.

32. Dr. Hanson (p.27) implies that this peer review resulted in a flow recommendation of more than 60% of the average annual flow: "Results of a peer review of the proposed bypass flows found that the median unimpaired February flow (which is typically substantially greater than the 60% annual average flow[sic]) would provide improved protection for fishery habitat within the river." To the contrary, the peer review recommended that the SWRCB adopt a bypass flow standard (proposed by NMFS) which calls for flow in tributaries equal to the median February flow for the period between December 15 and March 30, pending better information regarding hydrologic conditions in such small streams. This recommendation was solely for the purpose of limiting new water right appropriations during the winter months on tributaries. It was not a prescription for managing flow releases from upstream reservoirs on the mainstem of the Russian or any other river.

Trinity River Analogue

33. Dr. Hanson references the Trinity River salmonid restoration program as supporting his conclusion that 60% of the flow is necessary to restore salmon in the San Joaquin River. I am familiar with the Trinity River restoration program. I conducted field studies in the early 1990s as part of the U.S. Fish and Wildlife Service (USFWS) flow study (Kondolf and Wilcock 1996, Wilcock et al 1996), conducted studies on gravel augmentation for the U.S. Bureau of Reclamation in 2003-2004, and participated in expert workshops on the Trinity for the US Bureau of Reclamation in 2004 and 2005. The Trinity River flow schedule calls for approximately 51% of the average annual run-off,[2] not 60%. More importantly the

[2] Calculated by dividing the average annual yield at Lewiston (1,250 TAF) by the weighted average of year type recommendations.

Trinity River flow schedule is designed to satisfy specific statutory and trust responsibilities to the Hoopa and Yurok Tribes. It is specifically designed to "compel restoration of the rivers salmon and steelhead resources to pre-project levels" and satisfy the reserved "right to harvest quantities of fish on their reservations sufficient to support a modest standard of living" (USFWS and Hoopa Valley Tribe 1997). The Trinity flow regime is thus designed to restore large populations of several runs of fish, including the threatened coho salmon, spring- and fall-run Chinook salmon and steelhead trout, as well as non-fishery purposes such as an Indian harvest ritual. Thus, it is not surprising that the restoration flow regime comprises half of that river's flow. The flow regime I previously recommended for the San Joaquin, in contrast, was not designed to restore pre-project numbers of fish, but rather to restore fish in good condition as described by Dr. Moyle.

IFIM Method

34. Dr. Hanson cites (p. 25) the USFWS' Instream Flow Incremental Methodology (IFIM) study on spawning and passage flow requirements for salmon restoration (USFWS 1994). This is the only site-specific (or even region-specific) study cited by Dr. Hanson as the basis for his hydrograph. However, he disregards these IFIM results in establishing his passage and spawning flows (p.32). The IFIM study concluded that 150 cfs was adequate for passage, and that flows of 100-200 cfs optimized spawning habitat under the channel conditions then prevailing (USFWS 1994).

IFIM Regression Analysis

35. Although he disregards the site specific IFIM study on the San Joaquin River, Dr. Hanson chooses to rely on a regression analysis of multiple IFIM studies by Hatfield and Bruce (2000) to estimate optimal San Joaquin River mainstem streamflows for various life stages of Chinook, and used these estimates of optimal flows "as part of the technical foundation for establishing proposed salmonid restoration hydrographs" (p. 28). Dr. Hanson's reliance on Hatfield and Bruce (2000) is not well-founded.

36. The Physical Habitat Simulation (PHABSIM) model is part of IFIM. Hatfield and Bruce (2000) assembled results from 127 PHABSIM studies from a wide variety of rivers and concluded that that the flow identified as having the greatest habitat value, as indexed by a statistic called "weighted usable area" (WUA), could be roughly estimated from the mean annual flow in the reach.

37. Hatfield and Bruce (2000:1005) explicitly recognize that what they call optimum flow really "represents only the maximum value of an index for habitat and ignores many vital ecological and gemorphological processes." Moreover, Hatfield and Bruce (2000:1011) acknowledge that "Many criticisms have been leveled at IFIM and PHABSIM ..." However, they note (p. 1012):

> "Despite these concerns many still accept PHABSIM as valid because it is fish-based, site specific, and more flexible and refined than many of the alternatives. Therefore, the technique will continue to be used....*If we accept the limitations of PHABSIM*, the relationships presented here can be a useful tool for resources managers" (emphasis added).

In other words, the Hatfield and Bruce equations do not really estimate optimal flows. Rather, they estimate the results that would be obtained from a PHABSIM study. Ironically, the paper immediately following Hatfield and Bruce (2000) in the November 2000 issue of the North American Journal of Fisheries Management (Kondolf et al. 2000) criticized reliance on PHABSIM as the basis for a restoration flow schedule.

38. The final paragraph of Hatfield and Bruce (2000:1013) states that:

> "Some resource managers will be tempted to use our equations uncritically because so little information or effort is required to complete the calculations. We stress, however, that considerable statistical and ecological uncertainty would remain after such a calculation. We have presented a tool that is a reasonable alternative to a full-blown PHABSIM study, but fluvial systems are complex and many factors determine a healthy river. Natural resources cannot be well managed in the absence of acknowledging and planning for uncertainty (Ludwig et al. 1993). To do otherwise is to risk implementing faulty management decisions."

Dr. Hanson does not heed that warning.

Ramping Rates

39. As described above, Dr. Hanson misapplies the RVA analysis (Richter et al. 1997) to justify a flow schedule larger than actually needed for restoration of salmon. Rather than use the RVA statistics on ramping rates (rates of water level rise and fall), he adopts much lower ramping rates, without providing an ecological basis. The slower or smaller the ramping rate, the more water is required to ramp from winter base flows to high spring flows and back again to low summer base flows. The RVA statistics that Dr. Hanson generated (and provided as an appendix to his report) indicate that the pre-dam rates of water level rise and fall were much more rapid than the rates adopted by Dr. Hanson. The result of Dr. Hanson's choice of ramping rates is a substantial and ecologically unnecessary increase in the water quantity he prescribes for restoration.

Table 1. Ramping Rates: Historical v. Dr. Hanson's Recommendation

	Historical IHA (cfs/day)	**Hanson** (cfs/day)
Increasing Flows		
Average of all rising days	159	
High flows	455	
Small floods	508	
Large floods	10,900	
375 to 6150 cfs		35 to 65
Decreasing Flows		
Average of all falling days	-122	
High flows	-275	
Small floods	-607	
Large floods	-3299	
Greater than 1600 cfs		250
Less than 1600s cfs		100

Notes: Historical rates are derived from IHA analysis (Appendix B of Hanson report).
Dr. Hanson did not specify the basis for his proposed ramping rate.

Water Temperature Analysis for Use in Restoration Hydrograph Development

40. I agree with Dr. Hanson's decision not to rely on temperature analysis to determine the duration of the salmon migration period (ending in late April). Historic evidence from the 1940's of successful fish migration at similar flows and times of the year as I

recommended in my earlier report are sufficient to support the conclusion that it is possible to meet migration temperature requirements through April. I suggest adaptive management to determine if conditions in the lower river may be suitable to extend the migration period into May.

III. Limiting Factors Beside Flow That Need to be Resolved to Restore Salmon in the San Joaquin

41. Dr. Hanson (relying in part on the expert reports of Harvey and Donahue) states that numerous non-flow actions are required to meet the salmonid restoration objective. Dr. Hanson then specifies six actions in addition to flow that he states would be necessary to restore salmon. These are: spawning gravel augmentation and cleaning, construction of fish passage facilities and removal of barriers, installation of fish screens, isolation of gravel pits, improvement of channel configuration for flow routing purposes, and installation of large woody debris. I generally disagree with Dr. Hanson's opinion that this entire list of actions must be undertaken prior to releasing restoration flows. In the following paragraphs, I address the six limiting factors that Dr. Hanson described as necessary for restoration.

Spawning Gravel Augmentation and Cleaning

42. Dr. Hanson and Dr. Harvey assert that existing quantity and quality of gravel habitat on the San Joaquin is not sufficient to support restoration of salmon. It is my opinion that Drs. Hanson and Harvey underestimate the number of salmon that could (and would) spawn on the gravel beds currently located below Friant Dam. Furthermore, it is my opinion that Dr. Hanson and Dr. Harvey ignore or incorrectly assess the ability of salmon and flows to clean and improve the quality of spawning gravel over time.

43. The primary reason for Dr. Hanson's low estimate are:

a. his assumption that spring run salmon will only use 30% of the spawning habitat identified and mapped by between Friant Dam and Lanes Bridge and none of the habitat mapped between Lanes Bridge and Highway 99.

b. his overstatement, or at least estimation on the high end of the range, of the area required for each spawning redd.

c. his assumption that fall-run salmon will not return to spawn in the San Joaquin and use the redds downstream of Highway 99 particularly those immediately upstream of Highway 145.

44. I continue to hold the opinion that existing gravels are sufficient to support a self-sustaining population of Chinook salmon, and specifically, that the existing gravel beds are sufficient to support 2,500 redds or 5,000 individuals. As I stated previously, however, it is my opinion that modest efforts to increase the area of spawning habitat through gravel augmentation could increase the amount of available spawning habitat significantly at a relatively small cost. While such gravel augmentation efforts would be beneficial, they are not necessary for restoring salmon to good condition on the San Joaquin.

45. Dr. Hanson cites McMichael (2002) in Hanrahan (2004) to support the assumption that salmon would use only 30% of the available spawning habitat on the San Joaquin. I was not able to obtain a copy of the McMichael article, since it is not in a peer reviewed journal, and it was not provided with Dr. Hanson's report. Based on my review of Hanrahan (2004) and his description of McMichael, I do not believe it is reasonable to use Hanrahan or McMichael's studies to support the assumption that salmon will only use 30% of the spawning habitat available on the San Joaquin River. The Hanrahan (and apparently McMichael) papers describe a new method for predicting redd capacity in backwater areas of reservoirs on the Columbia River based on remote sensing (video of deep underwater areas) and hydraulic modeling.

46. Hanrahan did not measure the total amount of potential salmon habitat used by salmon and simply assumed it based on previous studies of salmon preferences. Hanrahan used his new method to estimate the universe of "potential spawning habitat" in the reservoir impounded by Chief Joseph Dam. Since 74% of the *potential* spawning habitat he identified was >4 meters deep and 88% of those areas contained water velocities of $\leq$ 0.75 meters per second, it is not surprising that he assumed that only 5-30% of the "potential" habitat mapped using this method was likely to be used by salmon. In the reach where Hanrahan conducted his study, upstream of Chief Joseph Dam, no salmon spawn, so he was not able to verify that only 5-30% of the habitat was used.

47. Dr. Hanson calculates spawning capacity on the San Joaquin below Friant, assuming a range of redd sizes from 55 to 216 square feet. In my opinion, it is likely that salmon will spawn at higher densities than those assumed by Dr. Hanson, particularly if spawning gravel is limited. Table 2 provides a range of spawning densities reported in the literature. The table is adapted from Healey (1991), with the addition of data from the Tuolumne and Stanislaus rivers, which are likely to be most relevant to the San Joaquin by virtue of their similarity. The median size red measured in the Stanislaus gravel surveys within 10 miles of Goodwin Dam (Mesick, 2002) was 33 square feet, significantly less than the redd size areas assumed by Dr. Hanson in his estimates of the carrying capacity of lower San Joaquin.

Table 2. Areas of Chinook Salmon Redds Reported in the Literature.

River	**Redd Area (square feet)**		**Source**
	High	Low	
Columbia	26	43	Healey 1991
Columbia tribs	42	70	”
Kamchatka	43	161	”
Nechako	5	296	”
Columbia	23	482	”
Stanislaus	11	101	Carl Mesick 2002
Tuolumne	45	60	EA 1992

Notes: Entries from Healey 1991 were compiled from various published sources

48. Dr. Hanson underestimates the carrying capacity of the existing spawning gravels. This is because he: (1) assumed that only spring run will spawn and only on the 281,400 square feet of gravels upstream of Lanes Bridge; (2) assumed that only 30% of the 281,400 square feet of spawning gravel measured by Stillwater Sciences between Lanes Bridge and Friant Dam would be utilized for spawning; and (3) assumed redd sizes ranging from 55 to 216 square feet. Under these assumptions, he arrived at spawning capacity figures of 1,535 to 391 females, or a total of 3,070 to 782 salmon (assuming a 1:1 female/male ratio).

49. Using the more realistic assumptions that (1) salmon will use 75% of the total habitat available between Friant Dam and Lanes Bridge (e.g., 75% of 281,400 square feet) (2) redd sizes will range from 35 to 100 square feet, and (3) the male-to-female ratio will be 1:1, I expect a total population of 4,221 to 12,060 fish under the restoration flow. Assuming that fish will use 75% of the spawning gravels between Friant Dam and Highway 99 (75% of 357,000 square feet) and will spawn at densities of 35 to 100 square feet, I expect a spawning population of 5,355 to 15,300 fish. The spawning population would even be greater if salmon use spawning gravel downstream of Highway 99, including the high quality gravels located just upstream of Highway 145.

Impediments to Upstream Migration of Fish

50. I now address Dr. Hanson's opinions about impediments to upstream migration of fish. While I am not a hydraulic engineer nor a specialist in fish passage, I am a hydrologist with a PhD in Geography and Environmental Engineering (Johns Hopkins University), teach hydrology and river restoration at UC Berkeley, and am generally familiar with requirements for fish passage as presented in sources such as Orsborn (1985). While I have not conducted a detailed analysis or detailed measurements of potential barriers to salmon migration in the San Joaquin River, I have visited most of the features listed as potential barriers. I have reviewed data on their dimensions and operations (Jones and Stokes 2001). Based on this assessment, it is my opinion that it is feasible to restore salmon passage on the San Joaquin River, with the understanding that implementation of engineering fixes would require a detailed engineering inspection and analysis. In the text below, I identify a number of options to improve passage, which would merit further study in an engineering analysis.

51. Dr. Hanson, citing McBain et al. (2002), states that several structures have been identified as fish passage barriers/impediments. Based on field visits, my review of McBain et al, (2002) and Jones and Stokes technical memorandum (2001) upon which McBain presumably relied, I conclude that these structures, with the possible exception of Mendota Pool, will not be insurmountable barriers to salmon migration under the restoration flow regime I have recommended. Furthermore, securing passage over or around Mendota Dam,

or improving passage around other structures, will not require the costly measures proposed by Mr. Donahue. I stand by my previously stated opinion that Mendota Dam is the primary existing impediment to upstream passage in the lower San Joaquin, and that and any passage impediments below Friant Dam can be feasibly corrected to permit passage of salmon.

52. Dr. Hanson's opinion does not appear to be based on field observations, measurements, or other data regarding structures that may be fish passage barriers. Rather Dr. Hanson cites only McBain and Trush et al. (2002). Dr. Hanson states that:

> "Significant structures within the mainstem San Joaquin River between Friant Dam and the confluence of the Merced River that have been identified as *barriers/impediments* to both upstream and downstream salmonid migration by McBain et al(2002) are illustrated in Figure 5 and include:…." (italics added for emphasis).

He then goes on to provide a verbatim list of structures from McBain and Trush et al. (2002), which I discuss in more detail below. Dr. Hanson lumps all of these structures into the generic category of barriers/impediments. He does not provide evidence that these structures are actually impediments to upstream or downstream passage. In this section, I address only the issue of upstream passage barriers and reserve discussion regarding potential downstream impediments for a separate discussion under the heading downstream fish passage impediments below.

53. The McBain et al. (2002) report, which exceeded 1,000 pages, devoted only Figure 7-12 and three sentences of text on p.7-61 to potential barriers. Figure 7-12 mapped "potential barriers." The text included a list of "impediments" to fish movement, but only three sentences describing these structures. The report did not present information supporting the interpretation that these features are in fact migration barriers. For Sack Dam, it acknowledged that any passage problem would be easily corrected, stating the existing fish ladder "…is in good condition, and would only require placement of flashboards and other minor modification for it to function well" (McBain et al. 2002:7-61). Dr. Hanson's Figure 5 was apparently taken from McBain et al. (2002), although incorrectly captioned. Dr. Hanson provides no other evidence or information (photos, measurements, or text) to support the

contention that these structures are, in fact, barriers, or under what flow conditions they might impede fish migration.

54. Upon close examination of Dr. Hanson's list of barriers, it appears that at least two and perhaps three of the 10 structures he identifies as barriers do not even exist.[3] Two other structures, Friant Dam and Hills Ferry Barrier are not even relevant to the question at hand, as explained below. Thus, out of a list of 10 structures, only five appear relevant: Mendota Dam, Chowchilla Bifurcation Structure, Sack Dam, Sand Slough Control Structure and the drop structure in the Mariposa Bypass.

55. Mr. Donahue also offers opinions about fish passage barriers on the San Joaquin. Like Dr. Hanson, Mr. Donahue does not offer any information (measurements, data, or analysis) to support the contention that various structures are actually barriers to upstream migration of fish or under what flows these structures may impede fish passage. He does not identify any documents that might have provided the basis for his opinions. It is impossible to confirm the validity of Mr. Donahue's opinions in the absence of basic information about these structures, such as their physical dimensions.

56. Mr. Donahue's opinion apparently conflicts with Dr. Hanson's regarding several of the impediment/barriers. On page 35, Dr. Hanson recites a long list of structures where design or construction of fish ladders or potential removal of barriers to migration "would be *required* as part of a successful spring-run Chinook salmon restoration program" (italics added for emphasis). Mr. Donahue, however, states the opinion that upstream passage facilities (fishway or bypass channel) are required at only five structures (Table 6), a list which is different from Dr. Hanson's: Mendota Dam (bypass), Mariposa Bifurcation Structures, Sand Slough Control Structure, Sack Dam, and the Chowchilla Control Structure. I thus infer that Mr. Donahue does not share Dr. Hanson's opinion that drop structures on the Mariposa or Eastside bypasses are barriers or impediments to fish passage. Dr. Hanson on the other hand does not mention the Mariposa Bifurcation Structures as potential fish passage barriers.

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[3] Dr. Hanson refers to a culvert at River mile (RM) 253 which washed out in the spring of 2005 and will not be rebuilt. He also referenced at least one earthen dam at RM 227 which was not evident when I canoed this stretch of the river in early July of 2005. Lastly, he refers to a drop structure in the eastside bypass at river mile 138 which I was unable to locate on aerial photographs of that reach of the river.

57. As discussed in greater detail below, I do not agree with either Dr. Hanson or Mr. Donahue that Sack Dam, the Mariposa Bifurcation Structures, and the Chowchilla Control Structure are barriers to upstream migration of salmon. I conclude that the head gate at the top of Reach 4B, which may be an impediment at high flows of 1,000 – 1,500 cfs when velocities through the culverts may be too high for passage, is probably not a barrier at moderate flows in the range of 200 to 1,000 cfs, depending on the operation of the slide gates. In the text below, I have specifically addressed each potential barrier or impediment identified by Dr. Hanson and Mr. Donahue, in downstream-to-upstream order.

58. *Hills Ferry Barrier.* This barrier is a removable barrier operated by California Department of Fish and Game (CDFG) for the sole purpose of preventing salmon from migrating up the San Joaquin. It would be a simple matter to remove the barrier for the purpose of allowing fish to migrate up the San Joaquin River. It apparently is already removed part of every year. According to Jones and Stokes Associates (2001), it has been placed by CDFG yearly since 1992, from approximately mid-September through mid December, to prevent fall run adults from migrating up the San Joaquin salmon, since the river is presently too dry and the salmon would die. Thus it would not be a barrier to spring run salmon that migrate in the spring and of course would not be a barrier to fall run if not reinstalled each fall.

59. *Drop Structure on the Eastside Bypass (River Mile 138).* Although McBain et al. (2002) listed a drop structure here, and Dr. Hanson asserts (without documentation) that there is a drop structure (Figure 5), my examination of aerial photographs did not show any drop structure at river mile (RM) 138. The Jones and Stokes and Associates (2001) technical memorandum on potential fish passage impediments did not identify any structure at RM 138 in the Eastside Bypass. If it even exists, this structure would be a potential barrier to fish only when flow is routed through the Eastside Bypass downstream of the Mariposa Bypass.

60. *Mariposa Bifurcation Structures.* I observed these structures in early June of 2005 when flood waters were flowing through the bypass system. I do not view them as barriers to upstream fish passage, although they may be barriers at extremely low flows. They are similar to the Chowchilla Bifurcation Structure, which I observed closely at flows of

approximately 1,000 cfs. I conclude that bifurcation structure is not a barrier to upstream migration. In any event, they would be passage barriers only if restoration flows were routed through the bypass during the salmon migration period. Flood flows do not occur in the fall, so structures in the flood bypass will not be a barrier to fall-run salmon.

61. These structures are located at the junction of the Mariposa and Eastside Bypasses. One structure controls flow into the Mariposa Bypass and the other controls flow into the Eastside Bypass. Dr. Hanson does not identify the Mariposa Bifurcation Structures as a impediment to fish passage. While stating that "two fishways will be required at the Mariposa Bypass bifurcation structure," Mr. Donahue provides no discussion of why or how he came to that conclusion. Mr. Donahue does not provide justification for this proposal of vertical slot fishways around both structures. It is not clear why such structures would be needed given that water flows through the structures (not over them) when there is flow in the bypass.

62. Jones and Stokes (2001)[4] surveyed the structures, describing them as the Mariposa Bypass Control Structure and the East Side Bypass Control Structure. They described the Mariposa Bypass Control Structure as a concrete dam with 14 bays, 6 of which are always open and 8 of which are equipped with radial gates. According to Jones and Stokes (2001), the vertical drop at zero flow is 4 feet and considerably less when water is flowing in the channel. The Eastside Bypass is a similar, with 6 bays that are all equipped with radial gates. The vertical drop at low flow is only 2 feet at zero flow. Given the modest drops, it is not clear that these structures would pose barriers to migrating fish. Neither Dr. Hanson nor Mr. Donahue provide any specific documentation to support their treatment of these as barriers.

63. *Drop Structure on the Mariposa Bypass (RM 147.6)*. This structure is only a potential barrier to fish when flow is routed through the Eastside Bypass downstream of the Mariposa Bypass. It is my opinion that this drop structure is not a barrier to salmon migration when flows are routed through the bypass. Jones and Stokes (2001) reported that the vertical

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[4] The JSA technical memorandum on fish passage barriers should be read skeptically since it appears to be based on rigid, faulty assumptions. Nevertheless, it is a better source then Hanson and Donahue since it provides measurements and detailed descriptions of each structure.

distance between the top of the structure and the pool below the dam at zero flow is 8 feet. They concluded that the structure is a barrier to fish passage, because 8 feet exceeds the 7.9-foot jumping capacity of salmon. In reality, salmon will never have to pass this structure at flows of zero cfs. As illustrated in Mussetter (2000) and Figures 8a and 8b of Dr. Harvey's report, stage (water surface) immediately below the drop structure increases substantially when water is routed through the Mariposa Bypass. At higher stages, the vertical distance between the water surface elevation and the crest of the dam is less than 8 feet, and therefore would not be a passage impediment.

64. *Culverts with Slide Gates at Top of Reach 4B, Upstream of Sand Slough Control Structure (RM 168).* In my opinion, the structure is not a barrier to upstream migration of salmon. Although the culverts within the Reach 4B headgates pose a barrier when the gates are closed, the gates are designed to be opened. Based on field inspection of the structure, it is my opinion that the gates would allow for fish passage at flows between approximately 200 – 1,000 cfs. Physical alterations such as construction of small notches in the concrete apron below the culverts could potentially improve fish passage. At higher flows, high velocities through the culverts may impede fish passage and therefore it would be beneficial to improve fish passage at the structure. Mr. Donahue estimates that such a structure would cost $285,000 plus contingencies. In my opinion, however, the allocation of the restoration flows I recommended in my original report, as between the mainstem and the bypass at the Sand Slough Control Structure, can probably be managed not to impede passage.

65. *Sack Dam.* I stand by my previous opinion that Sack Dam would not be a barrier to fish passage under their restoration flow schedule I recommended. Dr. Hanson states that "Sack Dam has a small but operational fish ladder that would need modifications to allow upstream and downstream salmonid passage." However, McBain et al. (2002), the only source he cited for his information on fish passage, stated: "The fish ladder at Sack Dam is in good condition, and would only require placement of flashboards and other minor modifications for it to function well." Despite this statement in McBain et al. (2002), and without articulating his own justification, Dr. Hansen proposes a costly new fishway over Sack

Dam. I have inspected Sack Dam and agree with McBain that, provided the boards were replaced, the ladder appears to be in good condition.

66. *Mendota Dam.* I agree with Dr. Hanson and Mr. Donahue that Mendota Dam is a passage barrier to salmon at most flow condition. I do not share their opinion that resolving this problem requires a multi-million dollar bypass system. Rather it seems plausible that the existing fish ladder could be made serviceable or replaced with a new ladder with a modest effort. In my previous report, I discussed how a fishway was constructed over Mendota Dam in 1908 following a citizens petition to the county board of supervisors, and how public servants, in a period of months, improvised a fishway over Sack Dam in 1948. I see no reason why a similar effort would not suffice today. I do agree, however, with Dr. Hanson and Mr. Donahue that a bypass channel would provide excellent passage conditions not only for upstream passage, and more importantly, downstream passage.

67. *Chowchilla Bifurcation Structure.* I stand by my previous opinion, based on a field visit to the face of the structure during flows this year, that the Chowchilla Bifurcation Structure would not be an impediment to fish passage at most restoration flows.

68. *Earthen Dam (RM 227) just upstream of Gravelly Ford.* It is my opinion that any temporary structure that may have once existed in the channel would not be a serious obstacle to salmon passage under restoration flows. I observed no evidence of any such structure or impediment when I kayaked the river from the Hanson Ranch (RM 233) to San Mateo Crossing (RM $<$ 211.5) in early July of 2005. I assume that any entity constructing such a structure would need to first obtain permission from the Department of Fish and Game, the State Lands Commission, the Regional Water Quality Control Board, and the US Army Corps of Engineers.

69. *Culverts on the San Joaquin below gravel mining ponds (RM 253).* These culverts washed out during the high flows of spring 2005. The property on which the culverts once existed is now in escrow, and the culverts are unlikely to be rebuilt.

70. *Friant Dam.* It is self-evident that Friant Dam is not an impediment to salmon passage in the river below Friant Dam, other than its dewatering of the river. Dr. Hanson (p. 19) provides no justification for including it in the list of impediments “identified as a limiting

factor affecting the ability to successfully restore a self-sustaining naturally reproducing salmonid population on the mainstem San Joaquin River."

Downstream Impediments to Passage

71. It is my opinion that Dr. Hanson and Mr. Donahue's proposal to construct a costly array of large screens at major diversions and channel bifurcations is a poorly conceived and heavily engineered solution to a problem that largely does not exist. I concur with Dr. Moyle's rebuttal report critique of the Hanson and Donahue reports on the matter of screens on large diversions and further concur with his opinion that screens are not necessary on small diversions. I strongly disagree with the Hanson and Donahue reports that screening of the bifurcation structures is necessary to prevent salmon mortality in the various flood bypasses.

72. Dr. Hanson and Mr. Donahue have embraced a costly solution without first bounding the problem that diversions and channel bifurcations might pose to the downstream migration of juvenile salmon. Their reports did not consider some fundamental questions that might guide a more reasoned approach to resolving this potential problem.

- When are juvenile fish migrating and when our flows diverted into bypasses and canals?
- How much of the rivers flow is diverted into canals and bypasses when juvenile fish are present?
- How many of the juvenile fish would be entrained into canals and bypasses?
- What would be the impact of a fraction of the juveniles being imported into the bypasses in canals on the total escapement? What fraction is too much?
- What are the risks posed to fish entrained into the flood bypass system? Do fish that are entrained into the bypass system fare better or worse than fish that migrate down the natural channel?
- What other strategies besides costly, maintenance-intensive screens are available to reduce the mortality risk associated with entrainment of juvenile salmon in the canals?

73. The answers to these questions are complex but fundamental to assessing the real impact of diversion and bypasses on the sustainability of salmonid populations. Obviously it would be best to have absolutely zero mortality due to entrainment, but that is neither realistic nor necessary. Prior to the construction of Friant Dam, salmon suffered losses to juvenile entrainment at Sack Dam, particularly during the drought periods of the 1930s and the regulated flows of the 1940s, but still persisted. Although stream flows may in some years have been higher than the restoration flows I recommended, all of the water diverted at the Mendota Pool originated from the San Joaquin, resulting in a substantial fraction of diverted flows. Under the restoration scenario I proposed in my previous report, I assume that Mendota Canal diversions would be met entirely by Delta Mendota Canal (DMC) deliveries and thus the theoretical diversion of water at Mendota Pool from the upper San Joaquin will be zero. Of course mixing of San Joaquin River and DMC water at Mendota Pool would result in some entrainment of San Joaquin River fish and water, but there is no evidence that it would be any worse than the entrainment pressures salmon endured during the 1930s and 1940s.

74. Below, I answer conceptually some of the questions I posed above, to illustrate how Dr. Hanson and Mr. Donahue have devised a solution for a problem that may not exist on the stated scale. After bounding the problem, I then offer my opinion regarding the potential strategies for reducing mortality by entrainment at specific structures where it may be beneficial and cost effective.

75. *When are juvenile fish migrating and when are flows diverted into bypasses and canals?* According to both Dr. Moyle and Dr. Hanson, juvenile salmon will migrate past the principal entrainment hazards at Mendota and Sack Dams primarily between November and May. According to Dr. Moyle (August 15, 2005 Report, p. 39), juvenile spring-run migrate in an even narrower window during “high flow events in winter months.” Flow diversions into the bypasses in February- April period are relatively infrequent and may be even less frequent under the hydrographs that both Dr. Hanson and I propose.

76. *How much of the river’s flow is diverted into canals and bypasses when juvenile fish are present?* Diversions at Mendota Pool and Arroyo Canal are relatively low during the

winter months when juvenile spring-run are migrating[5]. Thus, it is reasonable to assume that entrainment of juvenile spring-run would be relatively small under a restoration flow schedule, particularly since they tend to migrate during high flow events when the proportion of inflow to the proportion of diversions is relatively high. While entrainment of fall-run, which Dr. Hanson does not discuss, may be more of a problem, the increased spring pulse flow I have previously recommended will at least partially mitigate for the increased irrigation diversions during the March and April period. This question can be parsed even further. Do the fish migrate in short duration peaks as suggested by Demko (2000)? If so, diversions could perhaps be curtailed for short periods to reduce entrainment.

77. *How many of the juvenile fish would be entrained into canals and bypasses?* While the fraction of fish diverted may be related to the amount of water diverted, it is not necessarily proportional because (as Dr. Moyle points out), most spring run are nearly a year old by the time they migrate. They have some swimming ability with which to avoid being swept into diversions.

78. *What would be the impact of a fraction of the juveniles being imported into the bypasses in canals on the total escapement? What fraction is too much?* Would entrainment of thirty percent of the juveniles significantly reduce escapement (the number of adult fish that return to spawn)? Not necessarily, because the surviving fish may experience less foraging competition from their peers. In his report (p. 19), Dr. Hanson acknowledges that his expectation that entrainment would affect the abundant of adults is based on the assumption "that there is no density dependant or compensatory survival of juveniles." This assumption is not justified by any specific documentation.

79. *What are the risks posed to fish entrained into the flood bypass system? Do fish that are entrained into the bypass system fare better or worse then fish that migrate down the natural channel?* Dr. Hanson and Mr. Donahue apparently presume that they fare worse and thus justify the expense associated with screening the flood bypasses. This is contrary to the experience in the Yolo Bypass where, as reported by Dr. Moyle, salmon growth and survival

[5] Diversions to the refuge for winter flood up may be a problem and should be further assessed during the development of a cost effective strategy to reduce entrainment.

far exceeds salmon growth and survival in the mainstem Sacramento River. As Dr. Moyle pointed out, salmon in the Yolo Bypass grow at higher rates than salmon in the mainstem Sacramento due to lower predation pressures and better food resources. In fact, the evidence that inundation of the Yolo and Sutter bypass is beneficial to salmon is so compelling, that the CalFed Strategic Plan for Ecosystem Restoration lists restoration of bypasses as habitat as one of the twelve most promising opportunities for restoration in the Bay-Delta ecosystem. The bypasses on the San Joaquin system are different (with less complex habitat) than the Yolo Bypass and therefore would probably not provide the same level of benefits as observed in northern bypasses. However, Dr. Hanson and Mr. Donahue provide no basis for their implicit assumption that use of the bypasses would result in 100% mortality for the juvenile salmon. Of course, fish bypasses could be harmful to fish if inflows into the bypass were abruptly stopped and migrating salmon stranded. This has not been demonstrated to be a problem in the Yolo Bypass or the Consumnes River, where formerly diked floodplains have been reconnected to the channel. In any event, stranding could be mitigated by ramping down bypass flows gradually.

80. *What other strategies besides costly, maintenance-intensive screens are available to reduce the mortality risk associated with entrainment of juvenile salmon in the canals?* Neither Dr. Hanson nor Mr. Donahue evaluate alternatives to expensive screening or bypass facilities. In the paragraphs below, I offer some other options (particularly for Mendota Dam) that should be considered in the development of a strategy to reduce excessive entrainment mortality.

81. *Sand Slough Control Structure*. There is no compelling evidence that it is necessary to screen Sand Slough Control Structure to prevent fish from migrating down the Eastside Bypass. As discussed above, the screens proposed for the Sand Slough Control Structure appear to be based on the unsupported assumption that routing salmon through the flood bypass is inherently bad for fish.

82. The Sand Slough Control Structure is a concrete weir with a notch in the middle that is designed to control the flow split between the mainstem San Joaquin River and the Eastside Bypass. The structure creates a backwater that allows diversion into the Reach 4B

head gates that are located immediately upstream. The notch in the middle of the weir assures that some water, and presumably fish, will always flow into the Eastside Bypass even if the Reach 4B head gates were fully opened. This may not be good for salmon at low flows (<500 cfs) because it may result in excessively shallow conditions in the bypass, making juveniles vulnerable to predation by piscivorous birds.

83. There are several options for safely routing salmon down the river past the Sand Slough Control Structure during low-flow conditions (e.g., less that 1,500 cfs). One option may be simply routing all the flow (and fish) down the Eastside Bypass (which was historically known as Deep Slough) all the way to its confluence with the mainstem San Joaquin River near RM 138.

84. If the goal is to route low flows primarily through the mainstem channel (Reach 4B), then a second option may be to retrofit the Sand Slough Control Structure to prevent spillage and stranding of fish in the Eastside Bypass below that control structure during flows less than approximately 500 cfs. Placing sand bags in the notch of the concrete weir may be all that is necessary to accomplish this goal.

85. A third option may be to route salmon through the Sand Slough Control Structure downstream to the Eastside Bypass and then back into the mainstem at RM 148 via the Mariposa Bypass. This option would require equipping 6 bays on the Eastside Bifurcation Structure with radial gates (see description of the Eastside Bifurcation structure above).

86. A fourth option, which may hold promise at the high flows I have proposed for downstream migration during March and April, is to route salmon through all three channels. This would result in large areas of juvenile rearing habitat.

87. *Sack Dam.* I agree with Mr. Donahue and Dr. Hanson that a fish screen on the Arroyo Canal would be beneficial to reduce entrainment of salmon into the Arroyo Canal.

88. An alternative to screening Arroyo Canal for the benefit of spring-run may be to back off winter diversions at Arroyo Canal – particularly to the refuge and meet demands for that water from other canals or sources. A more sophisticated approach would be to monitor the movement of juvenile migrants, as has been done on other rivers (Demko, 2000), and to curtail diversion for short periods when the bulk of the population is moving downstream. Yet

another option worthy of consideration is to meet most winter and early spring demands with deliveries via the Poso Canal, which crosses over the head of Arroyo Canal, if current winter-early-spring flows through Poso Canal are less than canal capacity. This could largely obviate the need for diversions at Arroyo Canal during the juvenile salmon migration season.

89. *Mendota Bypass*. I also agree with Dr. Hanson and Mr. Donahue that construction of a bypass channel around Mendota Dam would be very beneficial and reduce entrainment of juvenile salmon into the diversion canals immediately upstream of Mendota Pool. However, I don't believe such a bypass is necessary, nor is it the only way to sufficiently reduce mortality from entrainment. It is important to recognize that Mendota Pool is a fundamentally different type of entrainment hazard than most river diversions, such as the Red Bluff Diversion Dam on the Sacramento River. Most diversion dams simply divert a fraction of the river flow, and with it some fraction of the fish if the diversion is not screened. Mendota Dam, however, does not necessarily divert San Joaquin river water, but rather diverts water delivered to the Mendota Pool via the Delta Mendota Canal. Thus, it is possible to maintain the full functionality of the irrigation diversions and assure passage of juvenile fish without screens if the waters of the San Joaquin River can be physically isolated from the water delivered via the Delta Mendota Canal. This is why Dr. Hanson and Mr. Donahue's proposed bypass could prove beneficial.

90. In addition to the bypass option, there are at least four other promising methods to reduce mortality from entrainment into the diversion canals immediately upstream of Mendota Dam.

91. First, screening all of the canal diversions at full capacity may prove more expensive then simply constructing a bypass. However, it should be explored before dismissing it out of hand.

92. A second option is installation of a permeable fish curtain to isolate water entering the pool from San Joaquin River water flowing through the pool. In actuality the water would mix somewhat, but fish would not be entrained into the diversion. I have reviewed Mr. English's conceptual design for such a fish curtain, and in my opinion it is worthy of implementation on a pilot basis. As discussed above, the curtain would only need to

be in place from October at the earliest to June at the latest – a period when diversion are relatively low. During the main irrigation season, the curtain could be removed, allowing Mendota Pool to operate as it does currently.

93. A third option is reconstruction of Mendota Dam in a fish-friendly manner. It is my understanding that the Bureau of Reclamation has plans to rebuild Mendota Dam. If so, it would be a relatively simple matter to build the structure in a manner that allows for the separation of San Joaquin River and Delta-Mendota Canal water in much the same way a fish curtain could function. Such a plan may require a siphon to service the Columbia Canal.

94. A fourth option is real-time monitoring and adaptive management of canal diversions during peak juvenile salmon migration.

General Channel Improvements In Reaches 1 And 2

95. The Hanson, Hradilek, and Harvey reports list other actions which these experts consider necessary for the restoration of spring run salmon in the San Joaquin. These actions include: reconnecting side channels, addition of boulders and large woody debris, and creation of low flow channels. These actions, while likely beneficial for fish, are not necessary to restore fish in good condition. The reports provide no data or analysis to support the implicit assumption that there is a shortage of suitable fish habitat of the kind that such actions would seek to remedy.

96. Similarly, isolation of gravel pits in Reach 1 would be beneficial for fish. However, as I stated in my earlier report, similar gravel pits exist along the Merced, Tuolumne, and Stanislaus Rivers where fall-run salmon successfully reproduce and sufficient numbers of juveniles outmigrate to sustain their populations. Therefore, isolation of gravel pits would be beneficial but is not necessary to restore salmon to the San Joaquin River.

97. Drs. Hanson and Harvey also recommended filling dredger pits to prevent their capture. Again the basis for this conclusion is not clearly stated. While captured gravel pits exist on the Tuolumne, Merced, and Stanislaus Rivers (as well as the San Joaquin), self-sustaining populations of salmon persist in these rivers despite the effects of the pits on channel processes and predation of juvenile salmon by exotic warm-water fish that inhabit the pits.

While filling or isolating captured gravel pits could have benefits for fish, such action is not *necessary* to restore salmon in the lower San Joaquin.

Channel Capacity

98. Dr. Hanson is correct in pointing out that the restoration flows he proposes would entail substantial increases in seasonal releases from Friant Dam in the late winter and spring. However the flows proposed in my report, with a few noted exceptions, are within the existing channel capacity of the river, and then most often at a fraction of the total capacity. The exceptions I noted were Reaches 2b and 4b.

Reach 2a Channel Capacity and Seepage Issues

99. Dr. Harvey suggests that the levees in Reach 2a need to be rebuilt. The basis for this conclusion is an assertion that the levees in this reach experience seepage problems and are unstable at flows of less than 8,000 cfs. Flows of 8,000 cfs already occur occasionally, such as this year. Dr. Harvey provides no evidence that the flow regime I have suggested would cause increased seepage or piping. The highest flows I have proposed in half of year types is 2,500 cfs, much less than the 8,000 cfs capacity. In wetter years, peak flows related to bed mobilization in Reach 1 are 8,000 cfs released from the dam for 2 hours, reduced to 4000 cfs within a few days. By the time this peak flow arrived in Reach 2, it would be attenuated and much less than the channel capacity. As such, the notion that levees in Reach 2A need to be replaced to accommodate the flows I have recommended seems without basis. For the same reason, the suggestion that slurry walls are necessary to address seepage impacts, is similarly unfounded. Furthermore, the flow regime I have prescribed may even reduce the magnitude and duration of seepage problems in late spring and early summer of wet years.

Reach 2b Channel Capacity And Seepage Impacts

100. It is my opinion that the restoration hydrograph I have proposed will not require substantial new construction of levees and slurry walls as proposed by Drs. Hanson, Harvey, and Hradilek. As I stated in my earlier report, the current stated design capacity of Reach 2B is 2,500 cfs. However, hydraulic modeling analyses performed by Mussetter Engineering

(2000) and illustrated in Dr. Harvey's report, provides evidence that reach 2B could convey substantially more than 2,500 cfs with relatively minor modification to the levee system. As shown in Figure 4.5 of Mussetter Engineering (2000), less than 10% of the approximately 22 miles of levee along Reach 2B would need to be modified to carry 4,500 cfs. Furthermore, these levee improvements may not be necessary to convey 4,500 cfs through Reach 2B if a bypass channel is constructed around Mendota Dam as proposed by Drs. Hanson, Harvey, and Hradilek. Flows would not be subject to the backwater phenomena caused by Mendota Dam if the bypass channel were constructed, and the majority of levees overtopped by flows of 4,500 cfs are downstream of the take-out for the bypass channel. As such, Dr. Harvey's suggestion that the entire reach needs new levees seems inconsistent with his earlier work. Furthermore, the 4,000 cfs maximum fish release I have proposed would result in a maximum discharge of only about 3,700 cfs in Reach 2B, due to losses between Friant Dam and the Chowchilla Bifurcation structure. Very short duration high flows for spawning habitat maintenance could be routed into the Chowchilla Bypass if they exceed the conveyance capacity of Reach 2B.

101. Dr. Harvey states that seepage occurs in Reach 2B at flows between 1,500 and 2,500 cfs, depending on the operation of Mendota Pool, but it is unclear based on the information provided by Dr. Harvey when or where he believes seepage impacts would occur under the hydrograph prescribed by Dr. Hanson. Dr. Harvey is clear that he thinks seepage is more likely to occur when the boards are in place at Mendota Dam, but he doesn't cite any specific references or observations that form the basis of his opinion that seepage actually occurs. I agree with Dr. Harvey that seepage is more likely to occur when the boards are in place at Mendota Dam.

102. It is my opinion that a bypass channel around Mendota Pool, in combination with a hydraulic control structure upstream of Mendota Pool as Dr. Harvey and Dr. Hanson suggest, could substantially reduce seepage and flooding impacts that currently occur in wet years and would also reduce the potential risk of seepage or flooding problems associated with the restoration flow regime I have recommended. McBain et al. (2002) report that seepage in Reach 2B was a direct result of diversion operations occurring at Mendota Pool, operation of the Chowchilla Bifurcation Structure, and releases from Friant Dam. Operation of Mendota

Dam affects seepage by raising the water surface elevations upstream. Dr. Harvey stated in his expert report that 2,500 cfs can be passed through Reach 2B without seepage impacts when the boards are not in place in Mendota Dam.

103. Assuming that Dr. Harvey is correct that seepage occurs at flows of 1,500 cfs when the boards are in place at Mendota Dam, I expect increased seepage impacts in Reach 2B to occur only during April of normal-dry and normal-wet years, under both existing conditions and my proposed hydrograph. Furthermore, the flow regime I have prescribed may even reduce the magnitude and duration of seepage problems in late spring and early summer of wet years. If a bypass channel is constructed as proposed by Dr. Hanson, Dr. Harvey, and Mr. Donahue, seepage may only occur for 15 days or less in late April of normal wet and wet years under the restoration flow regime I recommended.

104. Further analysis is needed to assess consequences of increasing the channel capacity to 4500 cfs, as Dr. Hanson and I have both suggested. In any event, Dr. Hradilek's recommendation of using slurry walls does not appear to be a reasonable and cost effective way of dealing with the potential impacts. According to Dr. Deverel, use of drainage canals is more the norm, and according to Mr. English, much more cost effective.

Reach 4B Channel Capacity And Seepage Impacts

105. As I stated in my earlier report, while restoration flows can be limited to the existing system capacity limitations, increasing the channel capacity of Reach 4B would provide ecological benefits and likely increase flexibility for managing flood flows. The theoretical design provided in Dr. Harvey's report represents a reasonable conceptual model for increasing the channel capacity. However, his conclusion that there would be resulting seepage impacts requiring mitigation is questionable according to Dr. Deverel's report. The mere fact that a significant portion of this reach is bounded by wildlife refuges is worthy of considering. Any seepage into surrounding refuge property may not be a problem at all and may actually be a benefit. Given this fact, Dr. Hradilek's recommendation to build 44 miles of slurry walls seems unwarranted. Moreover, according to Dr. Deverel, such slurry walls could

themselves cause high groundwater problems. The use of drainage canals rather than slurry walls, is far more common and cost effective as a solution as seen in Mr. English's report.

Gravel Mobility in Reach 1A

106. Dr. Harvey states that bed material mobilization requires flows in the range of 12,000 to 16,000 cfs. Dr. Harvey acknowledges, however, that "significantly more site-specific data collection is required to definitively identify those riffles where bed material mobilization will occur." I disagree with Dr. Harvey's opinion that bed material mobilization requires flows in the range of 12,000 to 16,000 cfs. I agree that he did not have enough site-specific data to identify whether riffles would be mobilized. As stated in my earlier report, I have conducted a site-specific assessment of bed mobility, and based on that assessment, it is my opinion that 8,000 cfs will mobilize most riffles in Reach 1A. In August 2005, after the high flows which peaked at approximately 8,000 cfs, I kayaked along most of Reach 1A and observed evidence of substantial bed mobilization at many riffles. Furthermore, I had placed tracer gravels in April before the onset of the high flows and observed that the high flows had mobilized most of the tracer gravels, some as large as 60-90 mm. I recovered some tracer rocks as far as 80 feet below the transect where they were placed. In some locations where woody debris or other local hydraulic features exist, I observed evidence of bed scour. These field observations suggest to me that mobilization of the current bed materials on riffles is substantial and widespread at flows of 8,000 cfs, not merely localized motion as Dr. Harvey has suggested.

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Dated: September 19, 2005

G. Mathias Kondolf

Figure 1. Comparrison of Kondolf and Hanson Recomended Dry Year Restoration Flows at Friant Relative to Average Calculated Dry Year Unimpaired (1896-1999)

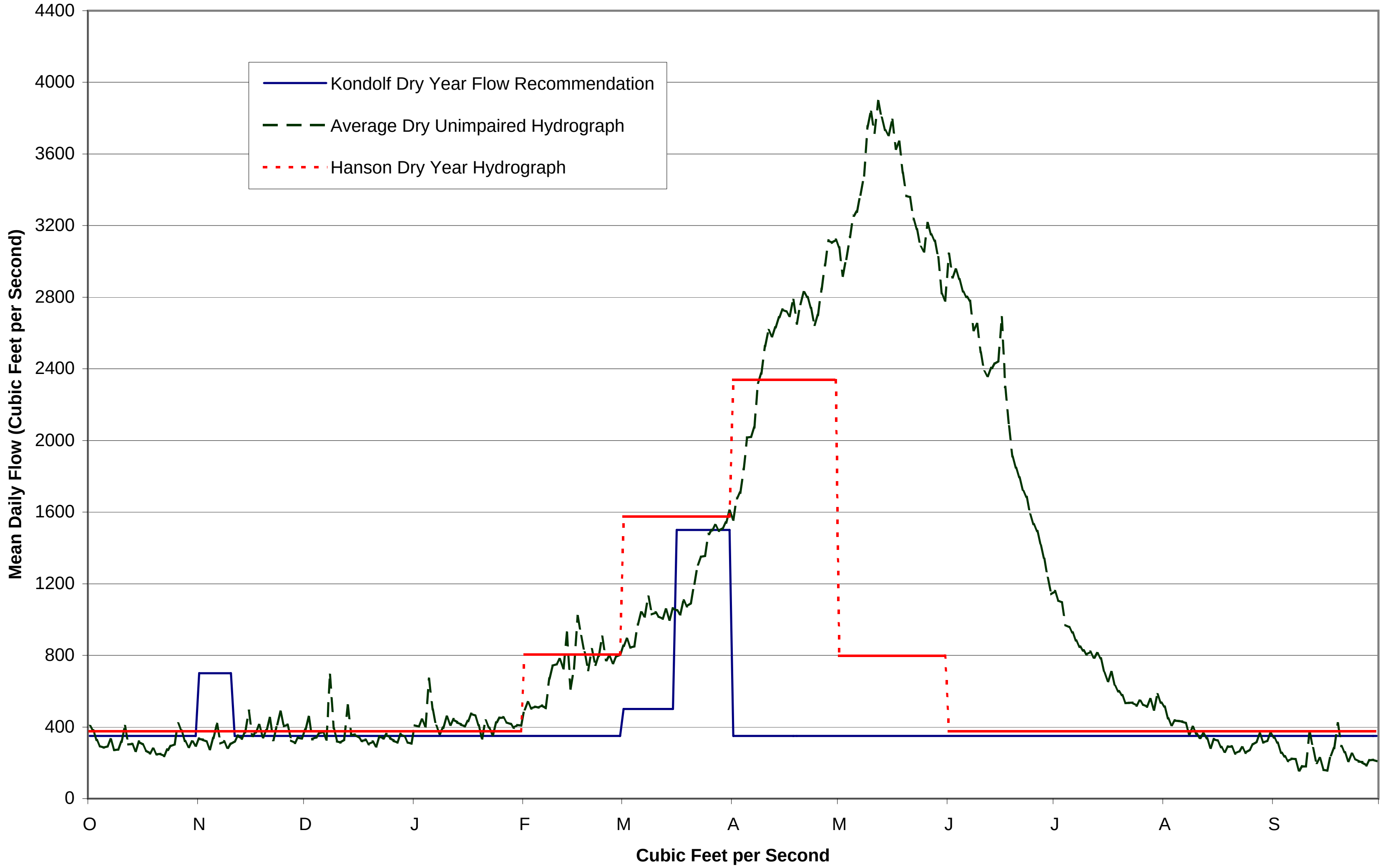


Figure 1. Comparrison of Kondolf and Hanson Recomended Normal-Dry Year Restoration Flows at Friant Relative to Average Calculated Normal-Dry Year Unimpaired (1896-1999)

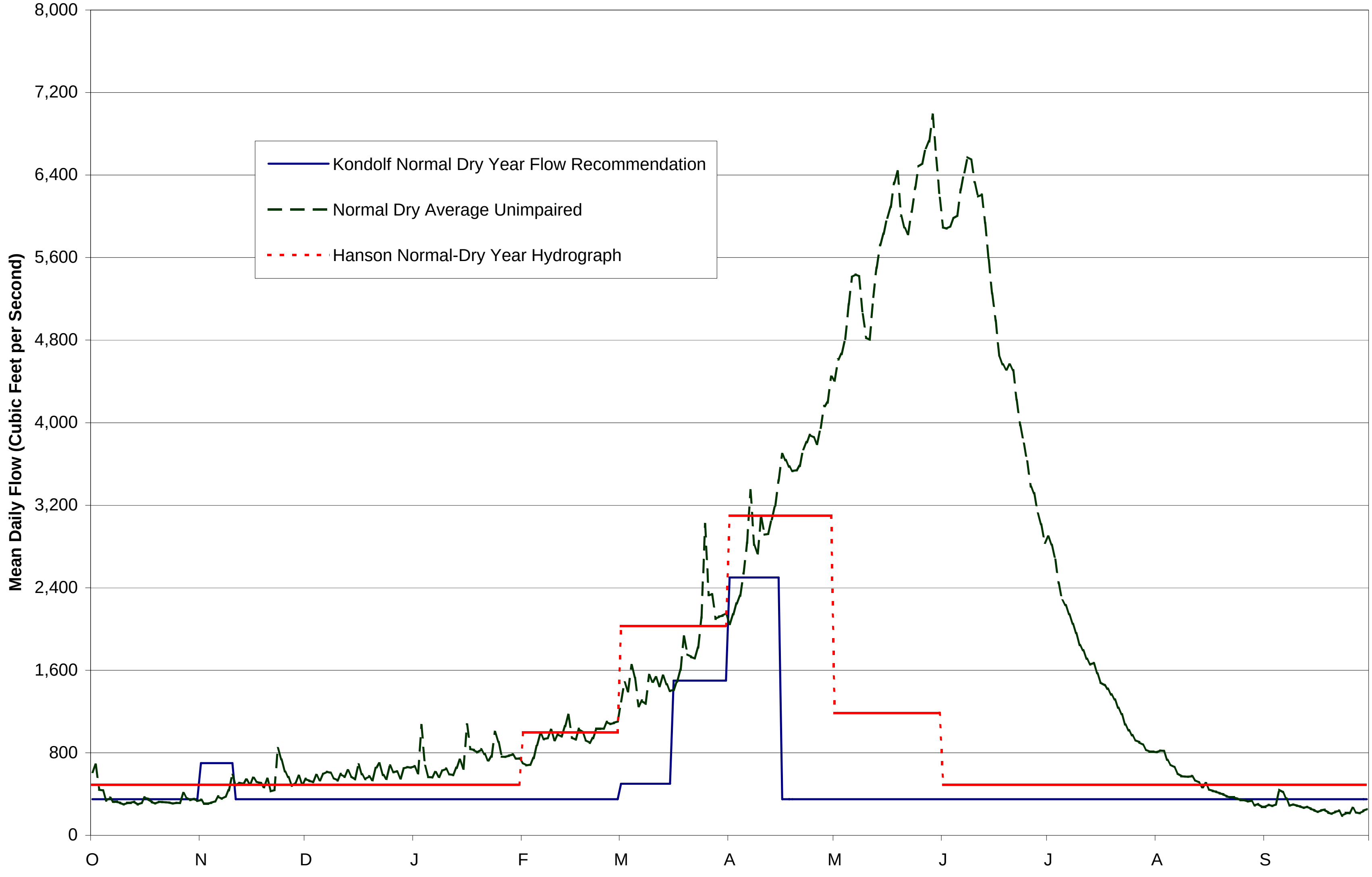


Figure 1. Comparrison of Kondolf and Hanson Recomended Normal-Wet Year Restoration Flows at Friant Relative to Average Calculated Normal-Wet Year Unimpaired (1896-1999)

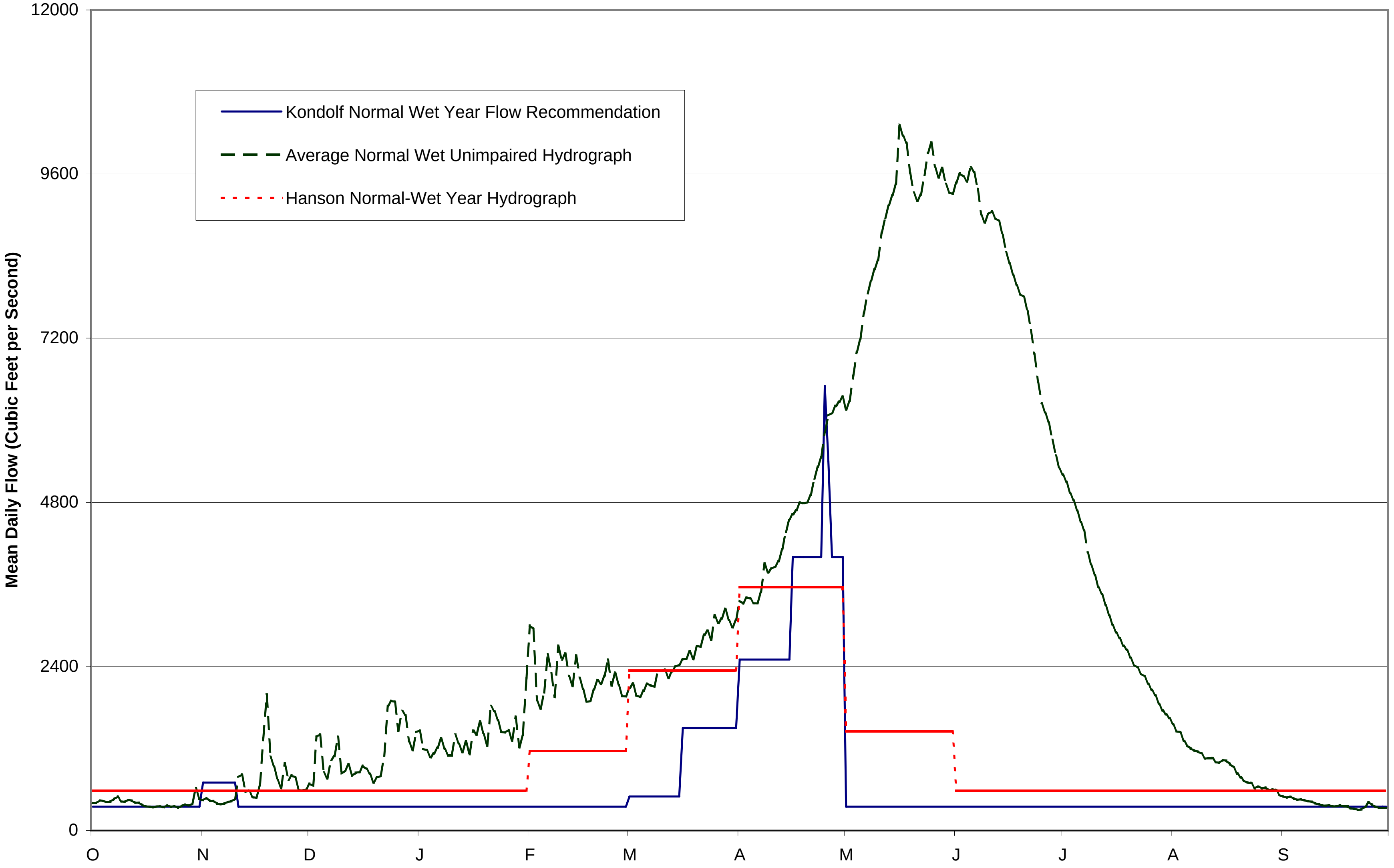
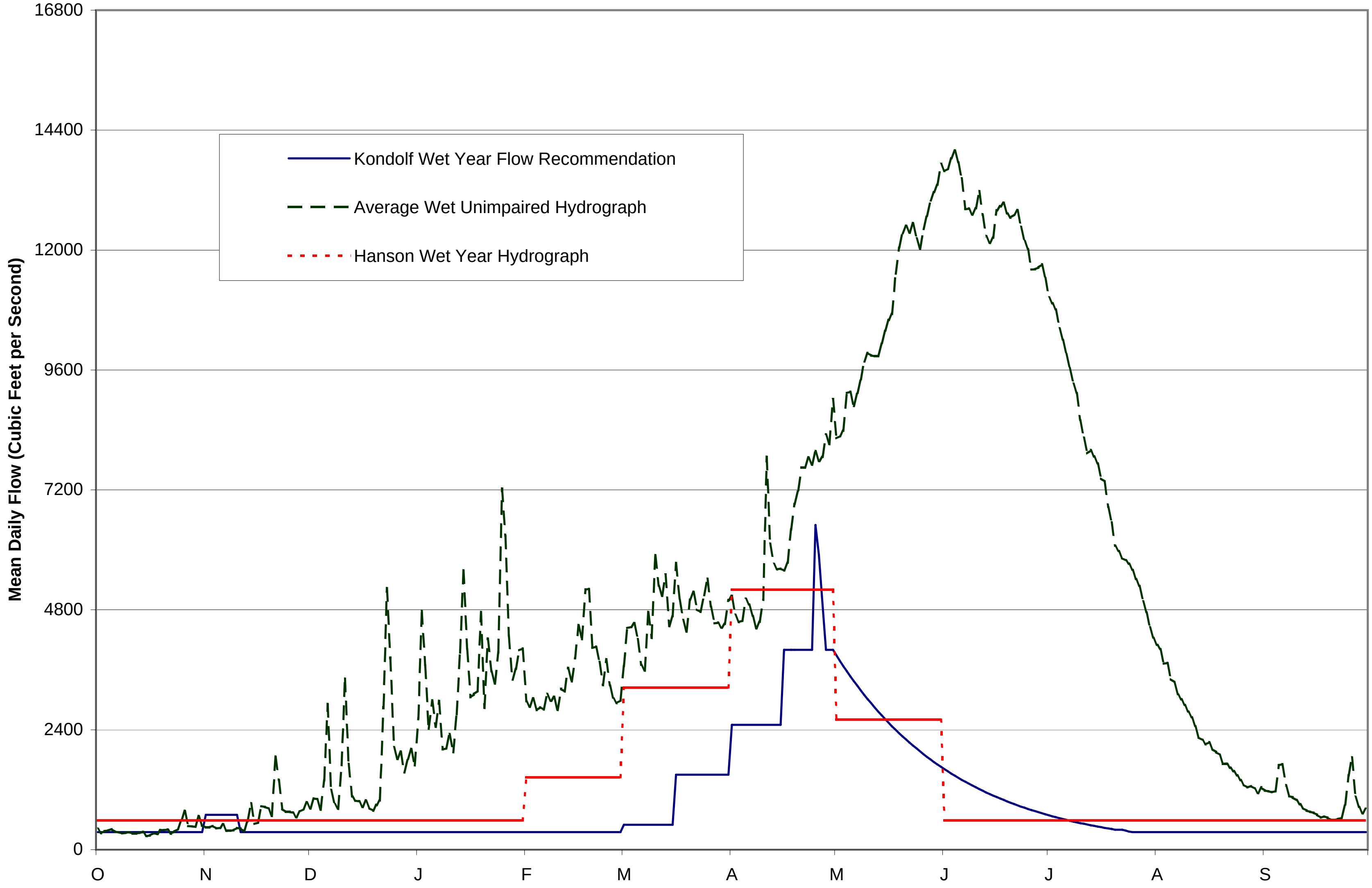


Figure 1. Comparrison of Kondolf and Hanson Recomended Wet Year Restoration Flows at Friant Relative to Average Calculated Wet Year Unimpaired (1896-1999)



APPENDIX 1

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	Date	Subject	Author/From	Received/To	Summary/Comments
Report	August, 1992	Friant Division Contract Renewals Fishery issues and preliminary Instream Flow recommendations	Rich Raines, Bureau of Reclamation E149	Interested parties	Attachment: Distribution list Enclosures- Draft Summary of Frai Fishery Issues
Report	September, 1994	*Final Report:* The Relationship Btwn. Instream Flow, Adult Immigration, & Spawning Habitat availability for fall-run Chinook Salmon In the upper San Joaquin River, CA	U.S. Department of the Interior Fish and Wildlife Service		
Bibliography	December, 1994	Biological Literature & Sources			San Joaquin River Comprehensiv Plan
Reconnaissance Report	June, 1995	Firebaugh & Mendola, San Joaquin River Basin, CA	US Army Corps of Engineers, Sacramento Dist.		Study to identify & evaluate alternative means of providing flo protection to Firebaugh & Mendo
Report	January, 1995	Historic Conditions In The San Joaquin River Watershed	U.S. Dept of the Interior: Fish & Wildlife Service, Sac. California	CVPIA San Joaquin River Comprehensive Plan of the U.S.	
Improvement Plan Report	1996	Interim San Joaquin & Tulare Basin Ecosystem Improvement Plan Report	U.S. Dept. of the Interior fish & Wildlife Service Sac, field Office	CVPIA San Joaquin River Comprehensive Plan of the U.S. Dept. of the Interior	Draft of the Improvement Plan Re
Proposal	1997	Jensen Ranch Riparian Habitat Acquisition & Restoration Proposal	San Joaquin River Conservancy, City of Fresno		
Physical Process Analysis	1997	SJRRHRP			SJRRHRP Physical Processes Analysis, Consultant Selectio Process
Report	January, 1997	San Joaquin River Data		Paula Landis	Water Surface Elevations Along Joaquin River

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Report	July, 1997	Soil Descriptions for areas along the SJR from Friant to Mendota	Dave Scruggs	Paula Landis	Reports on soil descriptions for areas along the SJR from Friant to Mendota.
Report	April, 1998	Historical Riparian Habitat Conditions of the San Joaquin River: Friant Damn to the Merced River	SJRRHRP		
Analysis	October, 1998	Friant Dam to the Merced River	SJRRHRP		~~Analysis of Physical Processes &~~ Riparian Habitat Potential of the SJR: Friant Dam to the Merced River (2 Binders of Analysis)
Draft Report	1999	1999 San Joaquin River Riparian Flow Release Pilot Project	Douglas DeFlitch, Friant Water Users Authority		Kevin Moody, San Joaquin River Riparian Habitat Restoration Program, U.S. Dept of the Interior Bureau of Reclamation
Report	1999	Evaluating Effectiveness of Flow Releases for Restoration of Riparian Vegetation on the San Joaquin River	Michael L. Scott, Gregor T. Auble & Patrick B. Shafroth		Date documented according to text.
Report	January, 1999	Meeting Flow for SJR	EA Engineering, Science, & Technology Lafayette, Sacramento, CA	U.S. Dept. of the Interior Bureau of Reclamation	Meeting Flow Objectives for the SJR Agreement 1999-2010. Environmental Impact Statement & Environment Impact Report (Final)
Report	April, 1999	SJR From Friant Dam to Gravelly Ford		U.S. Bureau of Reclamation Fresno, CA	Survey & Mapping Report: Topographic & Bathymetric Surveys for the SJR From Friant Dam to Gravelly Ford
Summary	April, 1999	Draft Evaluation: Riparian Restoration & Open Space Uses	Rivers, Trails & Conservation Assistance - Program National Park, Service		Draft Evaluation of Opportunities for Riparian Restoration & Open Space Uses, San Joaquin River: Firebaugh to Mendota Corridor
Evaluation Report	April, 1999	SJR: Firebaugh to Mendota Dam Corridor	SJRRHRP	U.S. Bureau of Reclamation Fresno, CA	Evaluation of Opportunities for Riparian Restoration & Open Space Uses (include draft & Electronically)

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Final Report	May, 1999	Sacramento and SJR basins	Mussetter Engineering & Jones & Stokes Associates	U.S. Army Corps of Engineers	Preliminary Draft Final Report: Sacramento & SJR Basins Comprehensive Study, Ca.
Data Report	May, 1999	California Department of Fish Game Natural Diversity Data Base			San Joaquin River Species - Friant to Mendota pool (several data reports attached) - Obtained as a reference
Final Report	June, 1999	Vegetation along the SJR	Jones Stokes Associates & Mussetter Engineers	U.S. Bureau of Reclamation Fresno, CA	Recommendations for Experimental Flow Releases to Benefit Riparian Vegetation along the SJR
Benefits Report	August, 1999	San Joaquin River Parkway & Conservation Trust	Dave Koehler	U.S. Bureau of Reclamation; Pablo Arroyave	Economic Benefits of the SJRP to the Fresno-Madera Region
Project Report	October, 1999	SJR: Firebaugh to Mendota Dam Corridor	SJRRHRP		Project Report on SJR: Firebaugh to Mendota Dam Corridor
Project	October, 1999	Jensen River Ranch	Jones & Stokes and Wildlands Inc.	San Joaquin River Parkway and Conservation Trust	Restoration Opportunities Working Paper
Plan	December, 1999	SJRRHP-firebaugh to Mendota Dam Corridor	Rivers, Trails & Conservation Assistance Program National Park Service		Public Outreach Plan: San Joaquin River Riparian Habitat Program Firebaugh to Mendota Dam Corridor
Pilot Project Team	2000	Design of Flow Release Schedules	Mussetter Engineering Inc.		Task 3- Design of Flow Release Schedules
Evaluation Report	March, 2000	Evaluation of Roughness Effects of Increased Vegetation Associated with 1999 Pilot Project Flow Release	Mussetter Engineering Inc. & Jones & Stokes Associates, In.	Friant Water Users Association	One final draft & 4 revised drafts dated May, 2000
Report	March, 2000	Hydraulic and Sediment Continuity Modeling of the San Joaquin River from Friant Dam to Mendota Dam, California	Mussetter Engineering	U.S. Bureau of Reclamation	
Assessment & Study	April, 2000	San Joaquin River Riparian Habitat Restoration Program 2000 Pilot Project			Draft: Environmental Assessment & Initial Study
Assessment & Study	June, 2000	San Joaquin River Riparian Habitat Restoration Program 2000 Pilot Project	URS Greiner Woodward Clyde	U.S. Bureau of Reclamation / Friant	Final: Environmental Assessment & Initial Study

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Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Report	April, 2000	Development of the San Joaquin River Restoration Plan			An element of the Restoration Work Plan for Development of a Program tc Achieve the Mutual Goals of the NRDC Coalition and CVP Friant Division Water Users Regarding Restoration of the San Joaquin River
Report	May, 2000	Development of the San Joaquin River Restoration Plan	Jones & Stokes	Friant Water Users Authority	Technical Proposal
Restoration Plan	May, 2000	San Joaquin River Restoration Plan Proposal	Jones & Stokes	Friant Water Users Association	Providing Integrated Environmental and Engineering Solutions for Fisheries Restoration
Report	May, 2000	Pilot 2000 Transect Locations	Natural Heritage Institute, John Cain	Pablo Arroyave: Bureau of Reclamation	
Report	July, 2000	Floodplain Restoration of the West Bear Creek Unit, San Luis national Wildlife Refuge California	Mussetter Engineering, Inc & Jones & Stokes	U.S. Fish and Wildlife Service	Purpose of this study is to interest other agencies in the potential for a partnership that would have the positive benefits of both ecological restoration of refuge-owned lands an the lowering of flood stage height
Strategies Report	August, 2000	San Joaquin River Restoration Strategies Report		*Scope-of- Work for* Jones & Stokes and Stillwater Sciences	
Report	September, 2000	Hydraulic and Sediment Continuity Modeling of the San Joaquin River form Mendota Dam to the Merced River	Mussetter Engineering, Inc.	U.S. Bureau of Reclamation	
Evaluation Report	October, 2000	Evaluation of Potential Increase in Millerton Lake Water Supply Resulting from Changes in Upper San Joaquin River Basin Projects Operation, phase 2	Huxley T. Madcheim P.E.	U.S. Bureau of Reclamation, Mid-Pacific Region	This report provides results of phas studies, which incorporates what w learned from the initial phase.
Report	October, 2000	Groundwater Model of the San Joaquin River Riparian Zone Friant Dam to the Merced River	Deborah L. Hathaway	Russell Grimes	Groundwater model of the San Joaquin River Riparian Zone, Fria Dam to the Merced River

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Restoration Plan	November, 2000	San Joaquin River Restoration Plan	The Friant Water Users Authority & Natural Resources Defense Council		Technical Workshop 1
Report	November, 2000	Riparian Vegetation of the San Joaquin River	DWR San Joaquin District	Bureau of Reclamation	
Study Evaluation	November, 2000	San Joaquin River Firebaugh, California			San Joaquin River Firebaugh, California Section 208 Study
Restoration Plan	November, 2000	San Joaquin River Riparian Habitat Restoration Plan		Submitted to: The San Joaquin River Parkway & Conservation Trust	Revised Proposal for the Riparian habitat Restoration Plan for the Milburn Unit & Hansen Farm
Report	December, 2000	Songbird Monitoring	Jeanne Hammond and Geoffrey R. Geupel		Songbird Monitoring on the San Luis National Wildlife Refuge: Progress Report for the 2000 field season
Report	2001	Invasive Weed Control and Prioritization Plan for the San Joaquin River	River Parkway Trust	San Joaquin River Riparian Habitat Restoration Program	
Report	January, 2001	Draft Pilot 2000 Monitoring Summary Report	Jones & Stokes	Marcia Wolfe	
Report	May, 2001	Technical Memorandum 5 Analysis of long list Alternatives: Development of Water Supply Alternatives for Use in Habitat for the SJR	URS	Friant Water Users Association & Natural Resources Defense Council Coalition	
Study	May, 2001	San Joaquin River Riparian Habitat Restoration Program 2001 Pilot Project	URS Corporation Oakland, California	U.S. Dept. of the Interior Bureau of Reclamation & Friant Water Users Authority	Environmental Assessment & Initial Study
Reconnaissance Report	June, 2001	Gravelly Ford gauging Station San Joaquin River, Fresno County, California	California State University, Stanislaus: Endangered Species Recovery program		Sensitive Species Reconnaissance Recovery Survey
Report	September, 2001	Final Conveyance of Refuge Water Supply for Mendota Wildlife Area EA/Negative Declaration	Tetra Tech, Inc	U.S. Bureau of Reclamation	

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	***Date***	***Subject***	***Author/From***	***Received/To***	***Summary/Comments***
Survey	September, 2001	Preliminary Surveys for Endangered and Sensitive Species & Small Mammal Trapping	California State University, Stanislaus: Endangered Species Recovery program		2001 Pilot Project of the San Joaquin River Riparian Habitat Restoration Program
Report	September, 2001	Channel Migration & Avulsion		Kevin Moody	
Report	September, 2001	MODFLOW Simulation of Transient	Tain-Shing Ma, Deborah L Hathaway,& Adam N. Hobson	Kevin Moody	MODFLOW Simulation of Transient Surface Water/Groundwater Interactions in a Shallow Riparian Zone Using HEC-2-Based Water Surface Profiles
Report	October, 2001	Gravelly Ford to Chowchilla Bypass Bifurcation Structure Levee Modification Ecosystem Improvement Initial Project	Jones & Stokes	U.S. Bureau of Reclamation	Sacramento and San Joaquin River Basins Comprehensive Study
Study	October, 2001	Sacramento and San Joaquin River basins Comprehensive Study	Ayres Associates	Jones & Stokes	Upper Sacramento River Flood Damage Reduction & Ecosystem Restoration Initial Project: Hydraulic Analysis
Report	December, 2001	Technical Memorandum on the Potential Barriers to Migrating Steelhead and Chinook Salmon on the San Joaquin River	Jones & Stokes	Friant & NRDC	
Report	December, 2001	Little Dry Creek Tech Memo, Framework for Developing Restoration Strategies, Potential Restoration Actions, and Gamming	Jones & Stokes		
Report	December, 2001	Potentials Benefits and Constraints of Alternate Flow Pathways Using Lone Willow Slough, Salt Slough, Pick Anderson Bypass, or Chowchilla to-Mariposa Bypass Routes	Jones & Stokes		Revised Initial Assessment Memorandum
Report	January, 2002	Revised Quantitative Objectives for the San Joaquin River Restoration Plan	Jones & Stokes	Friant & NRDC	
Report	January, 2002	San Joaquin River Restoration Plan Background Report	Jones & Stokes	Friant Water Users Authority & Natural Resources Defense Council	

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Pilot Project	January, 2002	San Joaquin Pilot Project 2000	Jones & Stokes	Kevin Moody	Final: Baseline Vegetation & Physica Variable Data Collection Summary
Study	April, 2002	San Joaquin River Riparian Habitat Restoration Program 2002 Experimental Project	URS Corporation Oakland, California, Friant Water Users Authority	U.S. Department of the Interior Bureau of Reclamation	Environmental Assessment & Initial Study
Report	May, 2002	Progress Report San Joaquin Restoration Plan Strategy Development	Stillwater Sciences		
Report	May, 2002	Riparian Vegetation of the San Joaquin River	Dept. of Water Resources	SJRRHRP	
Report	May, 2002	Nationwide permit No. 5 for installation of staff Gages, Crest Gages, & Water Temp probes (projects A thru C)in the SJR as part of the Friant Water Users Authority & Natural Resources Defense Council coalition's 2002 Experimental Project	Science Applications International Corporation	Mr. Brain Erlandsen & Mr. Matt Hirkala Sent To: Valerie Curley	
Plan	April -May, 2002	DRAFT: Water Supply Plan: Development of Water Supply Alternatives For Use in Habitat Restoration For The San Joaquin River			
Technical Memorandum	March, 2002	Initial Evaluation of Gravel Transport in the Gravel-bed Reach of the San Joaquin River	Stillwater Sciences	Yantao Cui to Files	For SJRRHRP reference
Technical Memorandum	March, 2002	Implementation of Brownlie's bed material equation in Excel/VBA for the preliminary gaming of the sand-bed reaches of the San Joaquin River	Stillwater Sciences	Yantao Cui to Files	For SJRRHRP reference
Report	June, 2002	SJRRHRP's environmental impact analysis document for future short-term experimental projects.			
Report	July, 2002	San Joaquin River Restoration Plan Background Report	Friant & NRDC		Final Background Report

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Source List	Date	Subject	Author/From	Received/To	Summary/Comments
Report	July, 2002	Request for section 401 Certification or waiver for components E.G., & H of the 2002 Experimental Project on the SJR Fresno & Madera County	State of California Central Valley Regional Water Quality Control Board	SAIC & Friant Water Users Authority	
Report	July, 2002	Submittal packages of the Nationwide Permit No. 30 and 33 for Component 3.6	Alicia Gasdick	Valerie Curley	
Report	July, 2002	Permit submittal materials for the Friant Water Users Authority & Natural Resources Defense Council 2002 Experimental Project on the San Joaquin River	Alicia Gasdick	Valerie Curley	
Proposed Action	July, 2002	Section 2 of the Programmatic Environmental Impact Statement/ Environmental Impact Report Administrative Draft.	URS Corporation Oakland, California	U.S. Dept of the Interior Bureau of Reclamation Fresno, CA & Friant Water Users Authority	Draft I: Alternatives including the Proposed Action
Report	August, 2002	Memoranda of modeling Analyses Presented by Mussetter Engineering, Inc. May 20 - 21, 2002	Stillwater Sciences	Friant Water Users Authority & Natural Resources Defense Council	
Study	October, 2002	FINAL Water Supply Study: Development of Water Supply Alternatives For Use in Habitat Restoration For The San Joaquin River			
Background Report	December, 2002	San Joaquin River Restoration Study Final Background Report	McBain & Trush Inc	Friant Users Authority & Natural Resources Defense Council	
Report	January, 2003	Riparian Songbird Inventory on the San Joaquin River - 2002 Progress Report	Julian Wood & Geoffrey Geupel	Valerie Curley	
Survey	January, 2003	Spotlight Survey for Mesocarnivores along the San Joaquin River Fresno and Madera Counties, CA	Howard Clark & Patrick Kelly	Valerie Curley	
Report	February, 2003	Draft Restoration Strategies for the San Joaquin River	Stillwater Sciences	Natural Resources Defense Council & Friant Water Users Authority	

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	***Date***	***Subject***	***Author/From***	***Received/To***	***Summary/Comments***
Report	February, 2003	Experimental Project- Corps additional information request for use of Nationwide permit No. 18 & 33	Alicia Gasdick	Valerie Curley	draft letter and figures to the Corps in response to their Sept. 6 2002 letter requesting additional project information for the use of Nationwide permit No. 18 and 33
Report	March, 2003	Restoration Objectives for the San Joaquin River	Stillwater Sciences	Friant & NRDC	Part of hard copy report. Whole report electronic
Draft Report	April, 2003	San Joaquin River 2002 Vegetation & Hydrologic Monitoring Project	Science Applications International Corporation	Friant Water Users Authority	
Report	May, 2003	San Joaquin River Restoration Strategies Report	Friant Water Users Authority & The Natural Resources Defense Council		
Data Report	February, 2004	Millerton Lake Reservoir Profile Data	Hanson Environmental, Inc.	FWUA and Reclamation	For SJRRHRP reference
File Report	June, 2003	Deployment of Lower San Joaquin River Thermographs in May 2002	California Dept. of Fish and Game, Region 4	FWUA and Reclamation	For SJRRHRP reference
Quarterly Report	May, 2004	Quarterly Report - Fish Sampling on San Joaquin River - 2004	California Dept. of Fish and Game, San Joaquin Valley, Southern Sierra Region	SJRRHRP	
Technical Memorandum	May, 2004	Water Quality and Temperature Station Set-Up and Coordination	Reclamation - MP-Region	FWUA and Reclamation	For SJRRHRP reference
Research Results	May, 2004	Review of Fishery Management Plans and Related Scientific Literature for Regulated Rivers	Hanson Environmental, Inc.	FWUA and Reclamation	For SJRRHRP reference
Technical Memorandum	May, 2004	San Joaquin River Fisheries Scientific Investigations and Recommendations: Fish Life History and Limiting Parameter Ranges	M.H. Wolfe and Associates Environmental Consulting	Mario Santoyo, Program Manager, FWUA and Valerie Curley, Program Manager, Reclamation	Extensive Fish Life History documentation also provided

Bureau of Reclamation - South-Central California Area Office - San Joaquin River Documents - as of September 2004

Source List	*Date*	*Subject*	*Author/From*	*Received/To*	*Summary/Comments*
Report	May, 2004	Terrestrial Biological Surveys Supporting Restoration Planning for the San Joaquin River, California	Prepared by Patrick A Kelly'	U.S. Bureau of Reclamation	