Supplemental Report of Kenneth W. Kirby, Ph.D.

INTRODUCTION

This report provides supplemental information to the Expert Report of Kenneth W. Kirby, Ph.D. dated August 14, 2005. This information is presented in response to expert reports submitted by the Friant Defendants in *NRDC v. Rodgers.*

During my review, I have focused on matters related to how water resource management may be affected during the restoration or rehabilitation of the San Joaquin River. I have not encountered any information that causes me to alter my opinions stated in my original report. However, I have refined my numerical estimates of the potential changes to water deliveries based on providing additional flows for restoration. Furthermore, this report refutes some specific items within some of the Friant Defendant's expert reports[1], and elaborates on some important topics related to water management covered in my original report that are absent in the Friant Defendant's expert reports.

SUMMARY OF OPINIONS AND CONCLUSIONS

Based on the detailed comments below, I offer the following summary of my opinions:

- All of the Defendant's reports I reviewed present a narrow view of the expected response by Friant contractors to the potential change in deliveries brought about by increasing releases into the San Joaquin River for restoration. The reports by Mr. Moss, Dr. Schmidt, Dr. Burt, and Dr. McKusick are based on a single alternative future scenario[2] provided by Mr. Steiner. All of these experts (aside from Mr. Steiner) assume that the only option available to the potentially affected Friant contractors is to indiscriminately pump groundwater to make up for the reductions.

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[1] This report is in response to expert reports prepared by Daniel B. Steiner, Dr. Kenneth D. Schmidt, Richard M. Moss, PE, Charles M. Burt, Ph.D., P.E. and Dr. Robert B. McKusick.

[2] While Mr. Steiner presents two scenarios in his results, only one represents a potential change to the system. One scenario (Current Releases Scenario) is used to represent current conditions, often referred to as a "no-action" condition. The other scenario (Spring-run Hydrograph) represents a single alternative view of the future.

This assumption is inconsistent with observed behavior of the Friant contractors. As a result, most of the analyses presented by the experts making this assumption of drastically increased groundwater pumping contribute little to no value toward an intelligent discussion about how to manage the system to both provide the necessary releases to restore the native fishery in the San Joaquin and meet the objectives of the Friant contractors.

- The Defendant's expert reports that I reviewed all ignored the central role that Reclamation can play in this process.

- The restoration hydrograph proposed by Dr. Kondolf is significantly different than the one modeled by Mr. Steiner. When the Steiner model is used with the Kondolf hydrograph, the potential average annual reductions in Friant deliveries is 206 TAF[3], as compared to the 452 TAF reductions shown in Mr. Steiner's report.

- Mr. Moss's analysis consists of assigning subjective ratings to five water management criteria (Factors) that are each intended to represent some aspect of the District's ability to respond to potential reductions in Friant deliveries. Mr. Moss makes a series of erroneous assumptions and conclusions about several of the rating categories, thus invalidating his subsequent composite evaluation.

- Most of the districts (7 out of 10) Mr. Moss selects to illustrate how difficult it will be for Friant contractors to respond to increased releases to the river are Class 1 only contractors and experience relatively small potential reductions under the Kondolf Hydrograph scenario. (Class 1 contractors are expected to receive 90% of their full Class 1 contract

[3] Reclamation has the opportunity to decrease the potential average annual reductions in Friant deliveries if they establish a means to store additional surplus flows as discussed in Case Y of the Water Supply Study (URS 2002).

amounts on average under the Kondolf Hydrograph Scenario as compared to 94% of their full Class 1 contract amounts under the Current Releases Scenario.)

- The Friant Defendant expert reports I reviewed do not adequately consider the many alternatives available to offset or eliminate potential reductions in deliveries caused by increasing releases to the river. The failure to consider these alternatives is particularly striking given that some of them are already being implemented.

- Dr. McKusick offers some strongly worded predictions about severe economic consequences that are not adequately supported by his analysis as presented. His report takes a very narrow view of future hydrologic conditions, appears to report partial information from his model results (by not reporting changes in net revenues), and does not address a widely accepted practice of considering the "next most economic alternative" with regards to his analysis of potential changes in agricultural production.

AN ALTERNATIVE VIEW OF NET REDUCTIONS TO DELIVERIES

All of the Defendant's reports I reviewed depend heavily on the results provided by Mr. Steiner in his analysis of how deliveries could change if Reclamation provides releases to the San Joaquin River to match the Spring-run Hydrograph. The simulated results contained in Mr. Steiner's report (and all of the other expert reports that base their analyses on Mr. Steiner's report) are based on one alternative future scenario.

Since the proposed river flow hydrograph presented by Dr. Kondolf[4] is significantly different than the Spring-run Hydrograph used in Mr. Steiner's analysis, I used the model in Appendix B of Mr. Steiner's report to produce simulated changes based on the Kondolf hydrograph to illustrate how the system could respond under different requirements for restoration. This analysis also allows me

[4] Expert Report of Professor G. Mathias Kondolf, Ph.D., August 11, 2005.

to assess how results from Mr. Steiner's model compare to the earlier analysis I provided in my original report.

Comparison of Results

The results from the Steiner model using the Kondolf hydrograph provide another alternative future scenario to compare with the Spring-run Hydrograph scenario presented by Mr. Steiner. In order to facilitate a direct comparison, I compare the results from the Kondolf Hydrograph scenario to the Existing Releases scenario just as provided by Mr. Steiner.

However, I want to note that the assumptions about existing minimum releases below Friant dam are slightly different between Mr. Steiner's Existing Releases scenario and Dr. Kondolf's hydrograph, shown in Table 1. The hydrograph specified by Dr. Kondolf recommends that during critically dry years the releases match those of recent history to fulfill minimum release requirements (equal to 116,662 acre-feet per year on average). While the minimum release volume matches the representation of minimum flows required in Mr. Steiner's Existing Releases scenario, the monthly distribution of those releases is slightly different as shown in Table 2. When comparing results for the Kondolf Hydrograph scenario and the Steiner Existing Releases scenario, the differences in assumptions about the monthly distribution of releases result in an unintended difference in deliveries during years in the Critical Low year type used by Dr. Kondolf. In practice, this difference would not occur.

Summary results are shown in Tables 3 through 6. Full model information and results are attached electronically in Appendix A.

Compared to Analysis in Kirby Report

In my original report dated August 14, 2005 I offered an analysis of the net quantity of water that would be required for restoration. In that analysis I used previously produced simulation results from the Baseline Model developed as part of the *Water Supply Study* (URS 2002), and approximated how net water deliveries would change if the draft Kondolf Hydrograph were implemented. As part of that analysis, I considered previously modeled results from two Baseline conditions, Case X and Case Y. Using that approximation, I estimated that "the expected amount of water that will need to be reallocated to satisfy the recommended restoration flows is somewhere between 168 TAF and 216 TAF per year for Case X and between 103 and 180 TAF per year for Case Y."[5]

Subsequent to receiving Mr. Steiner's expert report, I analyzed the potential reductions in deliveries when providing releases as specified in the Kondolf hydrograph for restoration using Mr. Steiner's Friant system planning model and produced very similar results to those for Case X in my previous analysis. Table 4 shows that the simulated expected reduction in average annual deliveries is 206 TAF.

Based on my work with the Steiner model included with his expert report, I have developed a better understanding of how Case X and Case Y results were produced as part of the *Water Supply Study* (URS 2002). It is now clear to me that in order to produce results similar to those I previously computed using data from Case Y, Reclamation would need access to some additional storage (surface or groundwater) to regulate the flows currently being delivered as "Other" water in Mr. Steiner's model.

Also in my previous report, I used model results from the *Water Supply Study* to approximate the potential reallocation of water by contract type to provide releases that match the Kondolf hydrograph. Those results are repeated in Table 7 of this report and compared to simulation results I produced using Mr. Steiner's model. As shown in Table 7, the results for reductions in total system deliveries are very similar using the two methodologies. When comparing reductions by type of delivery, the simulation using the Steiner model predicts slightly higher reductions for Class

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[5] Kirby 2005 p. 21.

1 and Class 2 deliveries and slightly lower reductions in "Other" deliveries than I previously estimated.

Compared to Steiner Spring-run Hydrograph Scenario Results

When comparing the simulated results for an operational scenario that releases flows to match the Kondolf hydrograph with the scenario that provides flows to match the Spring-run Hydrograph prepared by Mr. Steiner, the expected average total system reductions are about 45 percent less for the Kondolf Hydrograph scenario (206 TAF reduction for the Kondolf Hydrograph Scenario versus 452 TAF reduction for the Spring-run Hydrograph Scenario). This difference is significant, and of course has a direct impact on all of the other analyses performed using the results of the Spring-run Hydrograph to characterize broader system effects of the potential reduction in deliveries.

COMMENTS ON FRIANT EXPERT REPORTS

Steiner

I reviewed Mr. Steiner's report and the model and model results included in the electronic files contained in Appendix B of his report. I offer the following observations and opinions:

- As is common in these types of water management studies, the results presented in Mr. Steiner's report are based on changing the releases to the San Joaquin River in a prescribed manner, namely under a scenario labeled the "Spring-run Hydrograph". This is important to recognize, because if a different river release hydrograph is considered, then the expected impacts on the water management system can vary considerably from the results presented in this report (and other subsequent reports based on the results from this single scenario). Since the proposed river flow hydrograph presented by Dr. Kondolf is significantly different than the Spring-run Hydrograph used in Mr. Steiner's analysis, I used the model in Appendix B of Mr. Steiner's report to produce simulated changes based on the Kondolf hydrograph. The results of my application of the Steiner model are described in the previous section.

- In Section 19, Mr. Steiner concludes that the computerized model included in Appendix B is "well suited for this investigation and is typical of the type of model used by others in my profession to evaluate effects to water project operations due to alternative operation assumptions." I concur that this model is "typical of the type used by others in my profession" and as far as I know, this model is the most detailed planning model currently available for the Friant system[6]. However, as with all models, this one has some limitations inherent in its design, and these limitations should be kept in mind when reporting and interpreting model results. Specifically, this type of model attempts to reproduce important characteristics of delivery patterns that are similar to the characteristics of historical deliveries over some specific period of time. In the *Simulation/Validation* section of Appendix C of Mr. Steiner's report, annual simulation results are compared to annual historical data. Mr. Steiner states that:

> While at times there occur noticeable differences between historical and simulated annual delivery and river release volumes, the differences are reconciled in many instances and are largely due to the inability of the model to reflect discretionary and intermittent actions, such as flood management and canal maintenance. … The usefulness of this simulation model is the ability to compare the effects of single or multiple changes to hydrology or operational assumptions. Those changes will be systematically applied within the model providing a level-handed basis for comparison.[7]

As a result, this model (and all other water management system planning models like this one) is best used for comparative purposes to evaluate the broad, long-term effects of changes to the system being modeled. While the structure of this type of model produces monthly output, attempting to interpret significance or meaning from model output for specific months and specific locations should be viewed with caution. (No validation information is presented in Mr. Steiner's report for monthly information by location.) In general, the more specific the

[6] While Mr. Steiner describes this model as one to "evaluate effects to water project operations", this model is generally described as a planning model (as opposed to an operations model) in our profession based on its specific assumptions and working equations.

[7] Expert Report of Daniel B. Steiner, Appendix C, p. 8.

model output viewed, the less reliable it is to represent how the system would behave under the modeled scenario.

As to the model's suitability, I believe it is the best available planning model for this purpose at this time. However, refinements to this model or development of other models in the future can be very useful to support the operational planning of the Friant system to best meet the recent historical objectives along with the objectives of reestablishing the native fishery in the San Joaquin River. Some important improvements needed include representation of coordinated operations with groundwater, a more refined representation of flood control operations (including time intervals smaller than the monthly time steps currently employed), more explicit representation of demand on the system by district, and the integration of this system with other water resource management components in California.[8]

- In Section 18 Mr. Steiner describes how operations within the model are "adjusted manually to result in an operation that maintains reservoir storage at or above minimum storage while making releases to the river." However, upon detailed review of the model and model results, there are times during the simulation that the model violates the minimum storage requirement of 135 TAF both in the "Current Releases" simulation and the "Adjusted Spring-run Hydrograph" simulation.[9] If additional manual adjustments are made to completely meet minimum storage requirements in the model, the model results likely will be different than those reported, probably resulting in slightly lower simulated deliveries in both scenarios.

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[8] I am aware that recent improvements in the CALSIM II model will provide some of these improvements, but do not address the need for more explicit representation of demand along the Friant-Kern Canal, coordinated operations with groundwater, and more refined flood control operations.

[9] For the Current Releases simulation storage results are below 135 TAF in 1937, 38, and 77. For the Adjusted Spring-run Hydrograph storage results are below 135 TAF in 1931, 32, 44, 77, 78, 83, 88, 90, 91, 92, and 98.

- Mr. Steiner's report presents simulated values for "Other Water Deliveries" (Steiner, Table 12). These numbers are produced in the model using a surrogate demand for non-contract water in the Friant-Kern Canal and the Madera Canal when conditions in the system allow for that delivery. In order for the model to deliver "Other Water" there must be water available in the reservoir that otherwise would be released as a flood control release, capacity available in the canal receiving additional water, and a demand for the water along the canal.

  It is not clear how the demands being used (100 cfs for the Madera Canal and 1,200 cfs for the Friant-Kern Canal) in the Current Release and the Spring-run Hydrograph scenarios were selected. Specifically, it is not clear whether the results for "Other Water Deliveries" have been calibrated to recent historical data and if so, whether this calibration takes into account the quantities of flood water routed through these canals that are not put to beneficial use within the service area. This distinction is important when evaluating the change in "Other Water Deliveries" between modeled scenarios, since water diverted into the Friant-Kern and Madera canals for flood control purposes and is conveyed out of the system through the California aqueduct or other means does not provide any water supply benefits for the Friant division.

  In practice, the quantities of water delivered under the categories all represented in the model as "Other Water Deliveries" is quite varied and difficult to model because these types of deliveries are discretionary and the classifications can be revised during a contract year. Furthermore, Reclamation has exercised its discretion to change the classifications and allocation criteria over time. Summary tables in the *Water Supply Study* Appendix A, Section 2 summarize historical deliveries by multiple classifications, some of which are represented by the "Other Water Deliveries" category.

Moss

I reviewed Mr. Moss's report and I offer the following observations and opinions:

- In Section 2.2 Mr. Moss states that “These deliveries [referring to “Other Deliveries” as modeled by Mr. Steiner] are an integral part of the overall regional water balance, the loss of which would immediately result in increased groundwater overdraft within the region.”

  I agree that much of the water referred to as “Other Deliveries”[10] are an integral part of the overall regional water balance (as are any significant deliveries being put to beneficial use within the region), but I disagree with the conclusion that “the loss of which would immediately result in increased groundwater overdraft within the region.”

  This statement is misleading, and the information presented by Mr. Moss does not support his conclusion.

- The term “groundwater overdraft” is widely used and often misunderstood, and Mr. Moss does not provide a definition for this term to clarify what he means by it. Mr. Dudley of DWR Northern District points out how the use of the term overdraft can be counter productive when attempting to establish meaningful groundwater management objectives[11]:

> Many of the existing [groundwater] ordinances, unfortunately, embrace a safe yield -- overdraft concept. Safe yield and overdraft have widespread intuitive appeal and acceptance with much of the water community. Very few, however, fully understand the concept at a technical level, and even fewer can explain it in detail. In other words, everyone knows what it is, but no one can describe it. Even worse, these terms have been used so loosely for

[10] As mentioned above, it is not clear from the information provided in Mr. Steiner’s report whether the simulated values of “Other Deliveries” adequately account for the different types of “Other” water that are periodically conveyed through the Madera and Friant-Kern Canals. Specifically, in practice some of this water is purely flood routing and is not put to beneficial use within the region.

[11] *Basin Management Objective (BMO) For Groundwater Surface Elevations In Glenn County, California*; Appendix A (Attached)

so long that they have come to mean whatever anyone wants them to "... we must be in overdraft because I am having trouble with my well."

In my opinion, Mr. Moss's use of the term groundwater overdraft in this context does not contribute in any meaningful way to this discussion.

- Given its widespread use, and the widespread confusion about how to characterize groundwater overdraft, I am including a few definitions from others. Two recent publications[12] in California offer the following simple definition:

> The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.

Dr. Steve Deverel[13] suggests that a more useful definition is one that includes a consideration of optimal yield which stems from an analysis of economic and social benefits associated with beneficial uses, and the need for transient analysis of the basin to determine sustainable yields due to physical changes that occur from groundwater development activities (Freeze and Cherry, 1979).

Furthermore, in a letter[14] to the California Department of Water Resources Dr. Steven Bachman (submitted as the Association of California Water Agency Groundwater Committee Chair) cautions against the improper use of the term overdraft, writing:

> The discussion of overdraft should also emphasize and give an example of the importance of using an average hydrologic period to determine basin

[12] *Draft California Water Plan Update 2005*, Glossary and www.farmingtonprogram.org/glossary.html

[13] Pers. Comm. Dr. Steve Deverel, September 2005.

[14] Comments on California's Groundwater, Update 2003, Bulletin 118, a letter dated June 2, 2003 (attached)

> impacts. For instance, it would be incorrect to use a long drought period alone (such as occurred in the 1940s and 1950s) to determine the effect on groundwater levels in the basin. Instead, the period must represent a net average in conditions (determined by indicators such as cumulative departures of rainfall, streamflow, or the like) that may include both wet and dry climatic periods.

Given the nature of groundwater basins in this portion of California, groundwater levels are dynamic and subject to significant fluctuation over time and affected by changes in land- and water-management practices. Therefore, based strictly on the necessity for considering changes to groundwater conditions over a suitable time when assessing overdraft, Mr. Moss's assertion that decreases in Other Deliveries "would *immediately* result in increased groundwater overdraft" is misleading and cannot be supported.

- Mr. Moss's statement also implies that the region is currently in overdraft, since reductions in Other Deliveries would "result in *increased* groundwater overdraft". However, in a report[15] prepared by the Friant Water Users Association they evaluate the cumulative groundwater storage change from 1965 to 1999 and conclude that:

> …while there have been short term increases and decreases in storage in the Friant Division, on an average basis the operation of the Friant Division has been successful in regulating and stabilizing groundwater supplies over the 1965 to 1999 period.

This statement indicates that the Friant Water Users Association has determined that their service area is not in an overdraft condition when considered collectively.

- Furthermore, Mr. Moss neglects to mention that any water not delivered within the category of "Other Deliveries" to support restoration will be released into the San Joaquin River. These

[15] *Friant Division Cumulative Groundwater Storage USBR Water Supply Report & FWUA 2002 Update*, April 9, 2002 Friant Water Users Authority, contained in Appendix A, Section 1 of the Water Supply Study (URS 2002).

extra releases are expected to increase infiltration along certain reaches of the river, and therefore increase recharge in the groundwater basins hydraulically connected to the river. This additional recharge has the potential to raise groundwater levels in significant portions of the region[16].

- Furthermore, Mr. Moss's assertion that reductions of Other Water Deliveries "would immediately result in increased groundwater overdraft" is based on the assumption that the only viable alternative source of water is local groundwater pumping, and that there is no ability to improve storage and management of groundwater in the region. Indeed, throughout his analysis Mr. Moss appears to have assumed that numerous new and planned projects to enhance regional water supplies do not exist or should not be counted.

  The recent history of water management projects in this geographic region demonstrates that this is an unreasonable assumption. For example, water agencies associated with the Friant system have received grant funds within the past few years from Proposition 13 to build and implement conjunctive use and water supply projects (please see the *Local Response with State Assistance* section later in this report for more details). The grant application packages cited later in this report clearly indicate that the irrigation districts are sophisticated water managers that are planning to diversify and increase their water supplies and have explicitly considered how this type of project could offset potential reductions in deliveries that result from increased releases to the San Joaquin.

- In Section 2.2 Mr. Moss states that the results from Mr. Steiner's analysis are performed "under the existing water service contracts and operating rules of the Friant Division of the CVP (alternative allocation methodologies to those currently employed in existing Friant Division

[16] Expert Report of Dr. Steven J. Deverel, Ph.D., August 15, 2005.

contracts were not analyzed)." This is an important limitation on the conclusions presented in Mr. Moss's report. There exist many alternatives available to Reclamation that could produce very different results than the ones presented in Mr. Moss's report. For example the M&I Shortage Policy that Reclamation is applying to other CVP contractors, but for some reason not to the Friant Division, could be applied to limit or eliminate any adverse impact on Friant M&I contractors. Given the recent court decision that invalidates Friant long-term contracts, Reclamation has the opportunity to develop new contract provisions that better suit future conditions that include additional releases for restoration.

- In Section 2.3.2 (Availability of Alternative Local Surface Water Supplies) Mr. Moss describes how he characterizes the ability of each Friant contractor to use alternative local surface water supplies in the future. He states that "The extent to which other local surface water supplies are currently being used by a Friant Contractor is an indicator as to whether that use could be expanded upon." In Table 6, Arvin-Edison WSD is shown to have 0 acre-feet per acre from alternative local supplies. This information is inconsistent with other available information.

Specifically, Table A5 in Dr. Burt's expert report indicates that AEWSD has received an average of 47,635 acre-feet per year of local surface supplies between 1999 and 2003. Also, the Water Needs Assessment dated 6/21/2001 (included as an attachment to Mr. Moss's report) indicates that AEWSD used 23,336 acre-feet in a normal hydrologic year from the Kern River in 1996. Their forecast for 2025 predicts no Kern River supply in a normal hydrologic year, but does not state whether they plan to receive water from the Kern River in above normal hydrologic years. Given this evidence of recent use of alternative supplies by AEWSD (even in the absence of a long-term contract for these supplies), I would expect Mr. Moss to rate this category for AEWSD as "Fair", and yet he rated them as "Poor".

- In Section 2.3.3 (Availability of Friant Division Transfer Water Supplies) Mr. Moss describes his analysis of the potential use of within Friant Division transfers as an alternative supply. In Table 7, Mr. Moss reports historic quantities of transfers between Friant Districts between 1990 and 2003. This table demonstrates a very active transfers market within the Friant Division (over 66,000 acre-feet per year transferred in on average, and over 150,000 acre-feet transferred out).

  Then, Mr. Moss argues the following: "Likewise, if the water supply reductions forecast by Mr. Steiner exceed the volume of water transferred out, one can assume that historic transfers would not have occurred." This is an incorrect assumption based on economic theory. The historic information of transfers simply indicates the quantity of transfers that the districts found rational to execute, based on the hydrologic and economic conditions of that time. If hydrologic or economic conditions change substantially, we would expect from microeconomic theory that transfers would continue, but the pattern may change substantially.

  Mr. Moss then concludes, based on this faulty assumption that: "The reductions forecast by Mr. Steiner are large enough that they do effectively eliminate the ability of all Friant Contractors to transfer water to other Friant Contractors, as is readily apparent from Table 7." Again, the information in Table 7 does not in any way support the conclusion that reductions in delivery from Friant Dam would "eliminate the ability … to transfer water". On the contrary, the information in Table 7 indicates that the contractors have a solid ability to transfer water, and will continue to do so to maximize the financial return on their economic assets. Therefore, the "*Poor*" rating that was applied to all Friant Contractors for Friant Transfers in Table 10 is unjustified.

- In Section 2.3.4 (Permanent Planting Predominance) Mr. Moss describes "the ability of a Contractor to cope with surface water supply reductions". He states that "the amount of permanent planting acreage provides insight as to whether there is the option of fallowing ground from year to year (or not, in the case of predominance of permanent plantings) to the more severe drought conditions that would occur as a result of reduced Friant Division deliveries." In Table 8, footnote 14, Mr. Moss states that water used by M&I agencies is characterized by "a relatively 'hard' demand with immediate consequences if significant shortages are encountered". In economic terms, the conditions of a high percentage of permanent plantings or a "hard" demand for municipal and industrial uses, is described as an inelastic demand. What that means economically, is that these consumers of water are willing to pay significantly more not to reduce their water quantity than someone that has an elastic demand. Typically, the economic consequences of a decrease in water availability at their current price, is the willingness to pay a higher price to continue to meet their demand, resulting in a loss of consumer surplus. Contractors such as these are good candidates for being willing to buy transfer supplies during times of water scarcity.

- In Section 2.3.5 (Geographic Location) Mr. Moss discusses the ability of each Friant contractor "to participate directly in important water markets, especially those in water rich Northern California." Mr. Moss uses the physical distance and pumping lift in relation to the closest available outside source as an indicator of this ability. However, this approach does not seem reasonable, given that all of the Friant Contractors share at a minimum the connectivity provided by the Friant system. As mentioned later in this report, additional infrastructure is being developed that will increase direct connectivity for several contractors on the southern portion of the Friant-Kern canal to outside sources of water that Mr. Moss does not address (please refer to the *Local Response with State Assistance* section later in this report for specific details).

Again, recent history suggests that many opportunities exist to take advantage of supplies from outside the region. One specific example is the Exchange Contractors water transfer program.[17] Under this arrangement, the Exchange Contractors Water Authority will make available up to 70,000 acre-feet in any year for the Friant Contractors[18]. The EIS / EIR states:

> Friant Divisions districts most likely to be involved in a transfer or exchange with the Exchange Contractors are Arvin-Edison Water Storage District, Chowchilla WD, and Madera Irrigation District (ID). Kern-Tulare WD and Rag Gulch WD are Cross Valley Canal contractors who could participate in an exchange with Friant Division districts.
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> Friant Division contractors could receive the transfer water through wheeling arrangements utilizing CVP and SWP (California Aqueduct) facilities and other third-party facilities (e.g., Cross-Valley Canal contractors). Water exchange arrangements will be necessary to provide deliveries to specific Friant Division contractors, and it would be the responsibility of the potential water user to make those arrangements with all parties involved for conveyance.

This description clearly indicates that by utilizing exchanges and wheeling arrangements, water from outside the district can effectively be delivered anywhere the existing Friant system can deliver water. Another example of the connectivity of this system and the creativity of the water managers within the system is what occurred during the 1999 Pilot Project (DeFlitch and Cain 1999):

> The 25,052 AF that was measured as inflow to Mendota Pool and credited to SJRECWA allowed an equal amount of water to be pumped at the Delta. This water was then wheeled through the San Luis Canal and California aqueduct to be delivered as originally planned to Friant districts via the Cross-Valley Canal at the Tupman turnout. Once in the Cross Valley Canal,

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[17] Final EIS/EIR for the Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority 2005-2014, URS Corporation, December 2004, p. 2-18. (attached)

[18] The Exchange Contractors are planning to make available up to 130,000 acre-feet per year of water for transfer under this program. However they have specified in their EIR that only up to 70,000 acre-feet of that quantity would be made available to the Friant Division.

> this exchange water was delivered at the Arvin-Edison turnout or siphoned back into the Friant-Kern canal… As the summer progressed it became apparent that capacity constraints in the Cross Valley Canal were limiting the return of water to Friant contractors in a timely fashion so other means had to be developed to return water to Friant contractors. About 7,000 AF out of the 25,000 AF of exchange water was delivered to the Tulare Lake Basin Water Storage District, an SWP contractor with Kings River rights who was able to deliver an equivalent amount of its King River supply to Fresno Irrigation District, a Friant Division contractor.

- In Section 2.4 Mr. Moss states that "Table 10 shows that each Contractor will have difficulty responding to the shortages caused by implementation of the restoration flow release regime. Table 10 also shows that there will be significant adverse impact upon every Friant Contractor's ability to meet the existing demand of their water users." However, Table 10 does not support either of these conclusions. Table 10 shows a set of subjective ratings for five categories related to water management, based on a series of questionable or faulty assumptions as described above. Beyond that, no criteria are provided to indicate how Mr. Moss evaluated the "Factors" shown in Table 10 to reach his conclusions. Even if one were to accept the Factors as being reasonably representative, a contractor such as Fresno ID looks like it is pretty well situated to deal with changes to its supplies. It received two ratings of Good, one of Fair, and one Poor with an 80 percent of permanent plantings. Yet Mr. Moss lumped Fresno ID in with Districts such as Stone Corral ID that received all Poor ratings, when concluding that "each Contractor will have difficulty responding."

  Furthermore, Table 10 does not provide any information to the reader regarding "adverse impacts." In order to describe impacts, typically one provides some quantitative information to show a before and after condition, but no such data is provided here.

  Then, after reaching the conclusion that all of the districts would suffer the same fate of "difficulty responding to the shortages," Mr. Moss states in bold that "It is important to look at each of these Contractors individually in terms of their ability to respond." Mr. Moss goes on to emphasize that individual contractors "cannot arbitrarily share their assets (money, water or plant) with another Contractor without something meaningful in return." Again from an economic perspective, we would expect each contractor to act in their own best interest, which could lead them to work together to find cooperative solutions if they are facing some common adverse condition. In fact, they have repeatedly demonstrated that they are willing to do just that.

The other fact that seems to be completely absent in this entire analysis, is the role and ability of the Bureau of Reclamation to be an active partner in addressing the potential change in deliveries from the CVP due to providing restoration flows. The remaining portion of Mr. Moss's report about specific contractors consistently ignores Reclamation's potential role. One example project that Reclamation could develop is the Reclamation District 770 Pump-In Project.[19] This project is expected to make available up to 300,000 acre-feet of floodwaters per year from the Kings, Kaweah and Tule rivers. If this water were banked, it could provide significant annual yield to the CVP Friant Division.

- In Section 2.4.1 (Exeter Irrigation District) Mr. Moss states that "EID has no direct access to water outside of the region nor does it have a reliable method of exchanging water with those districts that may have direct access to the Delta-Mendota Canal, the California Aqueduct or the Cross Valley Canal. Consequently, any replacement or alternative surface water it receives would have to be delivered via the Friant-Kern Canal… Thus, EID has very limited ability to develop new yield from Friant and non-Friant sources." I fail to see why EID could not participate in a wheeling and exchange arrangement such as that described in the Exchange

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[19] Emergency Flood Control Operations Delta Lands Reclamation District 770 Pump-In Project Environmental Assessment, Bureau of Reclamation, February 2004.

Contractors Transfer Program EIS/EIR. Even if there is some complication that I am not aware of that limits their ability to participate in this type of transfer, the possibility certainly exists for Reclamation to implement a variety of projects where they could facilitate additional deliveries to EID.

- In Section 2.4.10 (City of Orange Cove) Mr. Moss states "They have no alternative except to purchase and exchange additional water supplies from outside of the region through other Friant Division contractors. It is not clear they could afford to make these investments." I disagree that this is their only alternative. For the reasons I described above, they will have the possibility to transfer water from other Friant Division contractors or enter into other cooperative arrangements. They also have the alternative to develop a treatment system for their nitrate contaminated groundwater to use during dry periods. DWR's *Water Desalination Findings and Recommendations* report indicates that some groundwater desalination facilities can deliver water for as little as $130 per acre foot, depending on local site conditions[20]. They can also participate with Reclamation to invest in projects that will provide additional deliveries from the CVP.

- In Section 2.4 Mr. Moss states that "the ability to respond to water shortage would be significantly difficult for the following Friant Contractors" and then lists ten Friant contractors, seven that have only Class 1 contracts. However, my simulation results of the Kondolf Hydrograph Scenario using the Steiner model shown in Table 6 indicate that Class 1 contractors will receive 90% of their full Class 1 contract amounts on average under the Kondolf Hydrograph Scenario as compared to 94% of their full Class 1 contract amounts under the

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[20] (DWR, 2003) states that "The total cost for brackish water desalination, including the amortized costs for planning, designing, and constructing such a facility and the costs for operation (e.g., energy, chemicals, disposal etc) and distribution of product water will be based on site-specific conditions and currently range from $130 to $1,250 per acre-foot."

Current Releases Scenario. This amounts to an average annual reduction of 64 acre-feet per year for the City of Orange Cove, less than what they have been transferring out of their district in recent years [21]. (In Dry years, Class 1 contractors receive 73% of their full Class 1 contract amounts under the Current Releases Scenario and 59% under the Kondolf Hydrograph Scenario. This results in an average delivery reduction of 195 acre-feet for the City of Orange Cove during dry years.)

- In Section 2.5 Mr. Moss states that “the opportunities to pump and export water from the Sacramento-San Joaquin River Delta have become increasingly constrained over the past two decades… Friant Contractors that may be able to physically access water from these facilities will have no priority for use of these facilities as third-party users. Dependence on these facilities as reliable alternative sources of water is unlikely.” While operations in the Delta have become increasingly constrained, Mr. Moss does not take into consideration options such as the one being presented by the San Joaquin River Exchange Contractors Water Authority’s Water Transfer Program. These Exchange Contractors have very reliable access to water deliveries from the Delta and Friant contractors can benefit from this water supply.

  Furthermore, several entities have continued to take advantage of opportunities to take delivery of water that they do not have a long-term right to from the Delta in cooperation with Reclamation. One example is the Forbearance Agreement[22] between the Sacramento Valley Settlement Contractors, Westlands Water District, and Reclamation in 2001. Under this agreement, Westlands obtained the right to receive 160,000 acre-feet of additional water from

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[21] Table 7 in Mr. Moss’s report indicates that the City of Orange Cove has been transferring 108 acre-feet per year on average out of their district between 1999 and 2003.

[22] Environmental Assessment for the Proposed Forbearance Agreement among Sacramento River Settlement Contractors, Westlands Water District, and the U.S. Bureau of Reclamation Through December 31, 2001, Bureau of Reclamation, April 2001.

Reclamation. Another, more recent example is the Glenn-Colusa Irrigation District transfer program[23] of 2003. This transfer program made water available from Sacramento Valley Settlement Contractors to several potential buyers south of the Delta, including Metropolitan Water District.

Schmidt

I reviewed Dr. Schmidt's report and offer the following observations and opinions:

- I disagree with Dr. Schmidt's opening statement that "Reduced deliveries of water from the Madera Canal and Friant Kern Canal will result in water-level declines, and increased land surface subsidence, and long-term changes in groundwater quality." on several points.

  First, to make a statement that anything *will* happen in the future related to water resource management is presumptuous. While I understand that authors sometimes take license with semantics to make a point, if an author chooses to do so, I would expect them to have substantial credible information to defend their strong prediction. However, the information presented by Dr. Schmidt is not sufficient to warrant such a definitive statement regarding what will happen in the future.

  One primary reason that the information Dr. Schmidt provides cannot support his opening statement, is that he makes several unrealistically narrow assumptions:

  - First, he presumes that deliveries will certainly be reduced by the amounts simulated by Mr. Steiner. However, as I discussed in previous sections of this report, this is not realistic to assume. With a different assumption regarding required flows for

[23] Finding of No Significant Impact and Environmental Assessment For Reclamation's Consent to a Water Sale And Transfer Under The Glenn-Colusa Irrigation District Sacramento River Settlement Contract For The 2003 Irrigation Season Water Transfer Program, Bureau of Reclamation, February 2003.

restoration, such as the hydrograph described by Dr. Kondolf, the resulting reductions in deliveries from Friant would be considerably less. Furthermore, the potential reductions described by Mr. Steiner are under the assumption that no other actions are taken by Reclamation to offset these reductions.

- Second, Dr. Schmidt assumes that when faced by a reduction in deliveries described by Mr. Steiner, the only option for the Friant contractors is to pump more groundwater. Again, as described above, this assumption is simply not plausible.

Aside from the initial faulty assumptions about changes in surface deliveries and expected contractor response, the analysis provided by Dr. Schmidt regarding how to predict changes in groundwater level is based on a simplistic statistical model subject to great uncertainty. Dr. Deverel[24] describes several of the theoretical deficiencies of this approach and offers some estimates as to the uncertainty around the information provided by Dr. Schmidt.

- When describing recent changes in observed groundwater levels during 1987 through 1999 "a near normal period of San Joaquin River streamflow at Friant", Dr. Schmidt noted that levels raised an average of 2.1 feet per year in the Arvin-Edison WSD. He states that the rise is "partly attributed to Cross Valley Canal deliveries during this period, which aren't expected to be to the same extent in the future,"[25] suggesting that the rise will not continue.

Then when estimating pumpage for the Arvin-Edison WSD, Dr. Schmidt appears to have discounted the recent active management of groundwater by Arvin-Edison, and in particular the groundwater banking program with the Metropolitan Water District.[26] As a result, Dr. Schmidt's analysis appears to not consider groundwater levels in the AEWSD and instead selects an earlier period of time to calibrate his model (1976 to 1999), reasoning that the earlier

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[24] Supplemental Report of Dr. Steven J. Deverel, Ph.D., September 2005.

[25] Schmidt 2005, p. 13 and 15.

[26] Schmidt 2005, pp. 22-25.

period is more representative of what will occur in the future. In my view, as illustrated by the conjunctive use expansion project recently receiving Proposition 13 grant funds, and the recent history of using alternative supplies shown in the spreadsheet[27] of district inflows included with Dr. Burt's report, Arvin-Edison can reasonably be expected to continue actions such as groundwater banking that Dr. Schmidt chooses to ignore.

- In the Projected Water-Level Changes section of his report, Dr. Schmidt predicts groundwater elevation changes over the next twenty years assuming "Current Deliveries" and "Reduced Deliveries" reported his Table 4. I note that under both of Dr. Schmidt's scenarios, groundwater levels are declining in several districts. The results for Arvin-Edison are particularly interesting because Dr. Schmidt predicts that under Current Deliveries groundwater levels would remain constant, but under Reduced Deliveries they would experience a 290 foot decline, the largest of any district.

  These results suggest that the Arvin-Edison WSD, one of the most proactive water management agencies in the Friant service area that has been experiencing a rise in groundwater levels in their service area in recent years, is expected to change their behavior and begin pumping their groundwater indiscriminately, resulting in the worst decline of all Friant contractors. This result does not seem plausible.

- On page 30, Dr. Schmidt concludes that as groundwater levels continue to decline, "groundwater pumpage is likely to be restricted throughout the Friant service area" to an amount "equal to or less than the present pumpage" in order to eliminate future water-level declines. I see this as an unrealistic prediction about future actions.

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[27] FWUA District Inflows Final.xls / Summary (2) indicates that Arvin-Edison WSD averaged 47,635 acre-feet of alternative supplies between 1999 and 2003.

According to the data presented in Table 4 of Dr. Schmidt's report, the Friant contractors would eventually reach the same result (of having to restrict groundwater pumping) under the Current Deliveries Scenario, given that water levels are predicted to decline for most of the districts.[28] It seems much more likely that the Friant contractors will take other actions to avoid having to regulate groundwater pumping, as they have since the development of the Friant Division.

- Furthermore, Dr. Schmidt assumes in his analysis that all reductions in Class 1 and Class 2 deliveries must be replaced with groundwater pumping. Aside from the reasons previously provided that this is not likely to occur because there are other more attractive options, the assumption is erroneous based on current and historical practice. Friant contractors are allowed to use Class 2 water for recharge, and they do[29]. Therefore not all Class 2 water that is delivered is applied to an immediate consumptive use. As a result, reductions in surface deliveries would not result in a one for one (1:1) substitution of increased pumping, since districts would not pump groundwater to then recharge it again. One other potential discrepancy arises due to differences in distribution efficiency as compared to local groundwater pumping versus conveyance from remote surface storage supplies.

McKusick

I reviewed Dr. McKusick's report on the economic impact of reduced surface deliveries and offer the following observations and opinions:

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[28] This prediction seems inconsistent with the information described in the *Division Cumulative Groundwater Storage USBR Water Supply Report & FWUA 2002 Update* (URS 2002) that concludes the groundwater supplies on average for the Friant Division are in balance based on data between 1965 through 1999.

[29] (Bookman-Edmonston 1979) p. 22.

- In the section entitled "Alternate Water Sources" Dr. McKusick states that groundwater will be limited to current levels or less (based on Dr. Schmidt's report), and that there are no viable opportunities to increase supplies from other sources[30]. These conclusions are not plausible for the reasons stated above.

- On page 30, Dr. McKusick states that "Impacts on the sector are likely to include the substitution of groundwater (where available) for reduced surface water supplies, increased pumping costs, reduced crop acreages, changes in cropping patterns, and reduced farm income." This conclusion ignores the possibility of investing in other supply options that can offset any potential reductions in surface water deliveries that might result from increased releases to the San Joaquin River.

- On page 34, Dr. McKusick states that "The declines in Friant water deliveries portend the same or greater impacts for the many small communities in that area as was evident in Mendota. It must be assumed that such reductions will be permanent, and will have severe implications for the regions municipalities." Again, this is an artifact of an unreasonably narrow view. There is no reasonable information presented to support the claim "It must be assumed that such reductions will be permanent". In fact, this assumption completely ignores the role of Reclamation in this process, and places undue emphasis on one potential alternative future scenario. As shown in the previously cited language in the Proposition 13 applications, at least some Friant contractors are already investing in alternative supplies that would render such a scenario unlikely to occur.

- On page 34, Dr. McKusick states that "The report also noted that reduced surface water supplies lead directly to increased use of groundwater, worsening overdraft conditions." It is not clear

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[30] McKusick 2005, p. 29.

what report Dr. McKusick is referring to, but this conclusion is not supported by Mr. Moss' or Dr. Schmidt's report for the reasons presented above.

- On page 34, Dr. McKusick states that "It is equally clear that reduced Friant deliveries to these communities and the farms in the area will have direct, adverse impacts in both the short run and the long run." As discussed for Dr. Schmidt's report, the use of the term "will have" in this statement is misleading given the high degree of uncertainty about the future and the narrow assumptions used to conduct this analysis.

- On pages 34 and 35, Dr. McKusick concludes that there will be a reduction in the net power generation due to the increased releases, but makes no mention of the possibility to expand generation capacity for releases into the river. As more frequent and additional releases occur through the dam (which provides a greater hydraulic head than releases through the canals), the potential exists to offset any losses due to reductions in generation on the canals. This option should be evaluated further to determine if additional hydroelectric generation capacity for releases below the dam could be economical.

- On page 38, Table 15 is a compilation of many of the erroneous or questionable factors and information produced by Dr. Schmidt and Dr. Moss.

- On page 128, Dr. McKusick reports the results of how contractors expected they would respond to a particular delivery reduction scenario in the future based on his survey. He states "The most frequently cited options were the purchase of water from other Friant districts, purchase from non-Friant districts, and increasing district water prices." This data suggests that when faced with a scenario of future surface water delivery reductions similar to that of the Spring-run Hydrograph scenario, district managers expect to rely heavily on water transfers and exchanges.

Yet, Dr. McKusick goes on to state "As noted in other sections of this report and other reports prepared for this case, the availability of water from other Friant districts may be substantially limited under either scenario." This statement suggests that Dr. McKusick either is discounting the opinion of the people that would be making the decisions, or discounting the validity of his survey by taking a position inconsistent with the survey respondents.

- I note that the survey questions (p. 129) did not include options such as invest in more efficient water application technology[31] or work with Reclamation to implement additional water supply projects.

- On p. 143, the "Hypothetical Response to Permanent Friant CVP Supply Reductions" questionnaire shows that the information presented as "representative" of the scenario already includes a key assumption about how the districts will respond. By stating that groundwater levels will decline and offering an estimate of the rate of decline, the author has already biased the view of the future by assuming that all districts will pump more (in fact, if the estimates for groundwater level decline was based on Dr. Schmidt's analysis, the assumption is that they will pump even more water than they currently apply.) Furthermore, the survey form has a note indicating that the analysis to compute declining groundwater levels was "based on the assumption that Friant CVP reductions would first be replaced by groundwater in all districts to the extent possible."

This amounts to assuming how the districts will respond first, and then asking them how they would respond to the results of the survey author's predetermined conclusion of how the

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[31] Dr. Gleick refers to a recent survey that indicates farmers in the San Joaquin Valley recognize the potential to improve their irrigation efficiency and that it would be one of their first choice actions to respond to water shortage (Gleick 2005, p. 5).

districts will respond. Even still, only one district responded that they would pump more groundwater from district wells, and only two districts responded that they would drill additional wells (see McKusick Figures B-1 and B-2).

- On p. 45, (Impacts of Reduced Friant Deliveries) Dr. McKusick states "with restrictions on the amounts of irrigation water available for crop production, in the short run farmers can be expected to respond in one or more ways, including increased pumping of groundwater (for those farmers who have access to the resource), switching crops, reducing total crop acreage, using fewer farm inputs (e.g. labor, seed, and fertilizer), or, in the long run, selling machinery and equipment or going out of business."

  There are other important and viable options, apparently not considered by Dr. McKusick, such as investing in more efficient and effective irrigation technologies, or investing in projects or arrangements that increase the amount of water available to the farmer. In fact, we would expect that if a farmer was faced with the prospect of going out of business or investing in a cost-effective project that could produce more water, and subsequently, more net revenue, the farmer would choose to invest.

- On p. 46, Dr. McKusick describes the assumptions for his Spring Run Scenario in 2025. If I understand the description correctly, the scenario presumes that the districts pump (on a one to one substitution for the potential surface water delivery reductions) for twenty years, and therefore cause much lower groundwater levels, and then at the end of the long decline in groundwater, they suddenly revert their pumping quantities back to those used in the Current Releases Scenario for the year of the analysis (2025). This effectively translates to a sudden reduction in the total available supplies by the expected net reduction of deliveries for the Spring Run Scenario (or about 360,000 acre-feet per year on average).

This set of assumptions represents a very narrow view of potential district responses, and seems to represent an implausible "worst-case" scenario for future conditions.

- On p. 47, Dr. McKusick uses the term "value of crop production" to describe model results in Figure 6. In subsequent discussions, he uses the term "crop value" and "agricultural value produced" interchangeably. These terms lead me to believe that the numbers presented from the Friant Division Production Model (FDPM) are production values. If this is the case, very key information is being excluded from these results, namely net revenue (where net revenue = production – expense). In other words, changes in production do not translate as direct loss to the farmer, because if they take some acreage out of production, they will no longer be incurring the expense of production, and therefore their net loss in terms of revenue would be much smaller.

- In traditional planning studies, potential losses in net revenue information for a possible future scenario are very useful to assess whether those that could potentially lose the net revenue would be able and willing to invest in additional water supplies such that their overall reduction in net revenues could be less.

- On p. 55, Dr. McKusick concludes that "the increased pumping depths induced by the Spring Run Releases (as estimated by Dr. Schmidt in his report) lead to significant increased pumping costs." The estimated increase is $24.2 million. This increase in expenses is essentially an artifact of the unusual combination of circumstances Dr. McKusick chooses to use for this modeled scenario.

- On page 62, Dr. McKusick describes that the direct impacts to the Friant municipal contractors "were calculated using the next most economic alternative, where those data were available." This is a very commonly used approach in economic analyses, and in my opinion should also have been applied to Dr. McKusick's agricultural production analysis. From an economic analysis, one cannot claim economic losses "will" occur based on a single analysis of potential change using one set of assumptions about future conditions, without also demonstrating that there are not other more economically viable options. Dr. McKusick fails to do so with the agricultural part of his analysis.

- On page 81, Dr. McKusick offers some strongly worded opinions and conclusions, such as Item 22 where he states "Because many acres of permanent crops will be lost, regardless of the groundwater assumption used, …" In my opinion, the analysis presented by Dr. McKusick does not provide a reasonable basis to make these sorts of definitive statements.

ADDITIONAL THOUGHTS ON SYSTEM RESPONSE TO CHANGE

One point that is notably deficient in all of the Friant expert reports I reviewed is how the water management system will likely respond to change. The Friant reports present a very narrow view that individual districts will have only one choice, to pump more groundwater. Based on the observed behavior of Friant contractors, this outcome is simply not plausible.

Water users can and will respond with a wide array of alternatives at various scales. A variety of alternatives can be implemented by local individual districts, through cooperation among districts, through the Central Valley Project (including the Friant Division and beyond), and potentially with other State and Federal involvement.

Local Response with State Assistance

A good indicator of the foresight and actions being demonstrated by the potentially affected districts are three recent projects that received funding from the State of California through

Proposition 13[32]. For example, the grant application submitted by Arvin-Edison Water Storage District[33] states:

> At present there are no environmental restoration flow release made from Friant Dam into the San Joaquin River, although such flows have been the subject of on-going litigation and settlement discussions. It is not certain when and if such flows will be required. It should be noted, however, that if such flows are required it will be of even greater importance to AEWSD to have facilities in place to store water in the underground when flood water is available from the San Joaquin River in order to offset water losses resulting from water made available for river restoration.

Similarly, the grant application submitted by the Fresno Irrigation District[34] states:

> The Waldron Banking Facility is a groundwater recharge and recovery project intended to supplement the Fresno Irrigation District's (FID's or District's) water supplies. The project is an agricultural and urban project that will provide water to urban suppliers, agricultural suppliers, and facilitate the environmental benefits of improving a river fishery.
>
> In addition to increasing the District's overall water supplies, other project goals and objectives include:
>
> - Sustain the water demands of the District's constituents and project partners.
> - Maintain the high quality water supply of the District
> - Sustain agriculture by generating revenue for the District
> - Facilitate the improvement of a fishery in the Kings River
> - Reduce the overdraft by dedicating 10% of diverted water to groundwater recharge
> - Creation of a large water-body that will benefit waterfowl and habitat

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[32] These projects have been provided as illustrations, and do not comprise a complete list of water management projects in this region receiving state funds.

[33] Application For a Groundwater Storage Program Construction Grant For The Arvin-Edison WSD Multi-Benefit Groundwater Storage Expansion Project, Section C, June 2003 (attached)

[34] Application For a Groundwater Storage Program Construction Grant For The Waldron Banking Facility by the Fresno Irrigation District, June 2003, Attachment B-1 and Attachments C-3 and C-8.

> From this analysis, the project is estimated to have an average annual yield of approximately 10,200 acre-feet per year.
>
> In addition to these benefits, it is acknowledged by the District that pending litigation between multiple entities involved in the San Joaquin River will likely result in the need to dedicate supply for environmental benefit along the river as part of the San Joaquin River Restoration Project. The development of this project will make additional water available to the District, which may ultimately be used to help meet these demands.

Furthermore, the grant application submitted by the Kern County Water Agency[35] states:

> After considering the dry-year supplies available to Friant Contractors on the southern portion of the Friant-Kern Canal, the Program includes improvements necessary to pump around three check structures… These improvements would permit direct deliveries to the following: Shafter-Wasco Irrigation District, Southern San Joaquin Municipal Utility District, Kern-Tulare Water District, Rag Gulch Water District, Delano-Earlimart Irrigation District, and North Kern Water Storage District. Deliveries made in this manner would allow the release of a portion of the Friant-CVP dry-year water otherwise available to these districts. Water so released could be used to mitigate water shortages in the remainder of the Friant service area, especially to permanent crops grown on the eastside with limited or no access to groundwater. The Program would provide for delivery of up to 50,000 acre-feet of dry year supplies within the Friant service area. KCWA's water supply modeling suggests that pump back deliveries will occur in 29 out of 72 years (40% of the years).
>
> The "Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program" will provide significant benefits to project participants, and will also create the opportunity for a wide range of water supply, quality, environmental and economic benefits to be realized throughout the local area and the CALFED solution area. Integration of the Program with existing facilities and infrastructure in Kern County will greatly improve the ability to store and convey water for a variety of purposes including; ecosystem restoration, increased water supply reliability, improved water quality and additional flood control.
>
> It is understood that the Program is not designed to produce a guaranteed water supply for environmental purposes. However, implementation of the Program will provide additional opportunities for Kern County facilities to develop water supplies

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[35] Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program, Attachment B-1 & H-8, June 2003. (attached)

> for ecosystem restoration. Kern County water banking facilities have already provided a significant portion of the water supply acquired by the Environmental Water Account (EWA) program, as much as 150,000 acre-feet. Construction of the Program facilities will provide even greater opportunity for future participation of Kern County water storage and recovery facilities in programs like the EWA.
>
> An intertie between the Cross Valley Canal and Friant-Kern Canal with associated pump-back facilities in the Friant-Kern Canal also provides the opportunity for significant environmental benefits. Efforts to restore the San Joaquin River have identified use of the Cross Valley Canal as important to returning water back to the Friant-Kern Canal after Friant water has flowed from the San Joaquin River and been introduced into the California Aqueduct by exchange. The ability to deliver water back to the Friant-Kern Canal is essential for restoration efforts to operate effectively and economically, and to not adversely impact Friant Division water contractors.

Therefore, it is clear that water managers in the Friant service area are already planning for changes to occur with their current supplies, and are proactively pursuing projects that will allow them to deal with those changes without having to resort to indiscriminate groundwater pumping.

Federal Response

The other omission in the Friant reports is any mention of the role Reclamation can play in addressing these potential delivery reductions for the current system. Clearly Reclamation has the ability to significantly offset, and even eliminate any net long-term reductions in delivery by pursuing and implementing additional water management projects like the ones described above.

Dated: September 19, 2005

Kenneth W. Kirby, Ph.D.

Information Considered

Application For a Groundwater Storage Program Construction Grant For The Arvin-Edison WSD Multi-Benefit Groundwater Storage Expansion Project, Section C, June 2003.

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www.farmingtonprogram.org/glossary.html

Table 1. Kondolf Hydrograph used in Steiner Model

	Water Year Type						
	Critical - Low	**Critical - High**		**Dry**	**Normal Dry**	**Normal Wet**	**Wet**
Time Period			**Time Period**				
Oct. 1 - October 31	160	160		350	350	350	350
Nov. 1- 6 Pulse	130	400	Nov. 1- 10 Pulse	700	700	700	700
Nov. 7 - Dec 31	120	120	Nov. 11 - Dec 31	350	350	350	350
Jan. 1 - Feb. 28	100	110		350	350	350	350
March 1-15	130	500		500	500	500	500
March 16-31	130	1,500		1,500	1,500	1,500	1,500
April 1-15	150	200		350	2,500	2,500	2,500
April 16 - 30	150	200		350	350	4,000	4,000
May 1 - Jun 30	190	215		350	350	350	2,000
July 1 - Aug. 31	230	255		350	350	350	350
Sept. 1 - Sept. 30	210	260		350	350	350	350
Total Release (acre-ft)	116,662	187,457		300,762	364,617	473,022	672,309
Assumed Riparian Release	116,662	116,662		116,741	116,741	116,741	116,741
Restoration Release	-	70,795		184,021	247,876	356,281	555,568

(Compiled from Table 1 A through F in Kondolf Expert Report)

Table 2. Comparison of Monthly Release Volumes for Kondolf Hydrograph and Steiner's Existing Minimum Release Scenario

Existing Minimum Release (TAF)													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
All Years	10.1	7.4	6.7	4.5	5.0	6.6	9.0	10.9	12.9	14.4	15.7	13.4	116.7

Fishery Hydrograph - Kondolf (TAF)													
Yr-Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
Wet	21.5	27.7	21.5	21.5	19.4	62.4	193.1	122.8	118.8	21.5	21.5	20.8	672.3
Normal-Wet	21.5	27.7	21.5	21.5	19.4	62.4	193.1	21.5	20.8	21.5	21.5	20.8	473.0
Normal-Dry	21.5	27.7	21.5	21.5	19.4	62.4	84.6	21.5	20.8	21.5	21.5	20.8	364.6
Dry	21.5	27.7	21.5	21.5	19.4	62.4	20.8	21.5	20.8	21.5	21.5	20.8	300.8
Critical High	9.8	10.5	7.4	6.8	6.1	62.4	11.9	13.2	12.8	15.7	15.7	15.4	187.5
Critical Low	9.8	7.2	7.4	6.1	5.5	8.0	8.9	11.7	11.3	14.1	14.1	12.5	116.7

Table 3. Comparison of Simulated Total Diversions

Total Diversions (Acre-feet)			
	Modeled Scenario		
	Current Release	Kondolf Hydrograph	Difference from Current Release
Average Annual	1,344,000	1,138,000	-206,000
Minimum Annual	322,000	312,000	-10,000
Maximum Annual	2,236,000	2,139,000	-97,000

Values are reported for contract-year (March – February) period

Table 4. Comparison of Average Total Simulated Deliveries by Year Type

Average Total System Water Deliveries by Year Type (TAF)			
	Modeled Scenario		Difference from
Year Type	Current Releases	Kondolf Hydrograph	Current Deliveries
Wet	1,904	1,740	-164
Normal-wet	1,564	1,276	-288
Normal-dry	1,032	828	-204
Dry	629	502	-127
All Years Ave	1,281	1,075	-206

Values are reported for contract-year (March – February) period

Table 5. Comparison of Average Total System Deliveries by Classification and Year Type

Average Total System Water Deliveries by Classification and Year Type (TAF)									
	Class 1			Class 2			Other		
Year Type	Current	Kondolf	Difference	Current	Kondolf	Difference	Current	Kondolf	Difference
Wet	800	800	0	872	763	-109	232	177	-55
Normal-wet	800	800	0	559	402	-157	205	74	-131
Normal-dry	796	750	-46	173	50	-123	63	28	-35
Dry	584	473	-111	5	0	-5	40	29	-11
All Years Ave	754	717	-37	393	287	-106	134	71	-63

Values are reported for contract-year (March – February) period

Table 6. Simulated Change in Average Water Deliveries

by District for Kondolf Hydrograph

Average Reduction to Water Deliveries - TAF						
Kondolf Hydrograph						
			Current Releases		Kondolf Hydrograph	
	Full Contract		Average Deliveries		Average Reduction	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Friant-Kern Canal Agricultural						
Arvin-Edison WSD	40,000	311,675	37,700	87,295	-1,834	-23,635
Delano-Earlimart ID	108,800	74,500	102,545	20,866	-4,988	-5,649
Exeter ID	11,500	19,000	10,839	5,322	-527	-1,441
Fresno ID		75,000		21,006		-5,687
Garfield WD	3,500		3,299		-160	
International WD	1,200		1,131		-55	
Ivanhoe ID	7,700	7,900	7,257	2,213	-353	-599
Lewis Creek WD	1,450		1,367		-66	
Lindmore ID	33,000	22,000	31,103	6,162	-1,513	-1,668
Lindsay-Strathmore ID	27,500		25,919		-1,261	
Lower Tule River ID	61,200	238,000	57,681	66,660	-2,805	-18,048
Orange Cove ID	39,200		36,946		-1,797	
Porterville ID	16,000	30,000	15,080	8,403	-733	-2,275
Saucelito ID	21,200	32,800	19,981	9,187	-972	-2,487
Shafter-Wasco ID	50,000	39,600	47,125	11,091	-2,292	-3,003
Southern San Joaquin MUD	97,000	50,000	91,423	14,004	-4,447	-3,792
Stone Corral ID	10,000		9,425		-458	

Tea Pot Dome WD	7,500		7,069		-344	
Terra Bella ID	29,000		27,333		-1,329	
Tulare ID	30,000	141,000	28,275	39,492	-1,375	-10,692
<u>Madera Canal Agricultural</u>						
Chowchilla WD	55,000	160,000	51,838	44,813	-2,521	-12,133
Madera ID	85,000	186,000	80,113	52,096	-3,897	-14,105
<u>San Joaquin River Agricultural</u>						
Gravelly Ford WD		14,000		3,921		-1,062
<u>Friant Division M&I</u>						
City of Fresno	60,000		56,550		-2,750	
City of Orange Cove	1,400		1,320		-64	
City of Lindsay	2,500		2,356		-115	
Fresno County Water Works District No. 18	150		141		-7	
Madera County	200		189		-9	
Total	800,000	1,401,475	754,004	392,531	-36,673	-106,277
Current Deliveries Other water delivered:	134,303				Reduction in Other water delivered:	-63,171

Table 7. Compare Results from Two Methods Used to Calculate Expected Annual Average Reductions to Deliveries that Could Result from Making Releases as Specified in Kondolf Hydrograph

Expected Annual Average Reductions to Water Deliveries (TAF)			
	Analysis Method		
Delivery Type	Approx. with WSS Results[36]	Steiner Model[37]	Difference
Class 1	28	37	9
Class 2	86	106	20
Other	106	63	-43
Total	220	206	-14

Appendix A Steiner Model Applied to Kondolf Hydrograph

(Results Provided Electronically)

[36] As performed in Kirby 2005 p. 22.

[37] Kirby used Steiner Model to simulate making releases to match Kondolf hydrograph